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DEPARTMENT OF THE INTERIOR
ALBERT B. FALL, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

MINERAL RESOURCES

OF THE

UNITED STATES

1919

G. F. LOUGHLIN
Geologist in Charge, Division of Mineral Resources

PART I—METALS

G. F. LOUGHLIN, Geologist in Charge

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1922

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MINERAL RESOURCES OF THE UNITED STATES, 1919—PART I.

MINERAL RESOURCES OF THE UNITED STATES IN 1919.

INTRODUCTION.

By G. F. Loughlin,

Geologist in Charge, Division of Mineral Resources.

Statistics of mineral production in the United States for 1919 reflect the reaction from intensive production for war purposes and the unsettled state of industry in general. Production of special "war minerals" rapidly subsided, although not to its pre-war status. These minerals, however, even under the stimulation of war demand, had contributed only in very small part to the country's mineral production. The principal decline was due to diminished production of coal and the major metals. Petroleum increased about 6 per cent in quantity and 8 per cent in value, but structural materials, due for a rapid recovery from the low demand during the war, were retarded until late in summer, when their production increased very rapidly.

The total value of all mineral products in 1919 was about $4,588,600,000, 17 per cent less than in 1918. The value of metal products decreased 37 per cent, but the value of mineral fuels and other nonmetallic products decreased only 4 per cent. This small decrease for nonmetals was due to higher prices in 1919, and the tables in succeeding pages will show much higher rates of decrease in quantity for some commodities.

A fair contrast between present and normal conditions is afforded by comparison of production in 1913 and 1919, with the latter year's total value recalculated on the basis of prices for 1913. Such a comparison for most mineral commodities is presented on page 8A and indicates an increase of 81 per cent in total value due to increase in price. The increase in value of metals and ores as a whole was 57 per cent and that in nonmetallic commodities was 97 per cent. This recalculated value for 1919 is very little different from the corresponding value for 1913. In using this table it should be borne in mind that only those products for which figures of both quantity and value are available have been considered, and that the total value of the entries is not the value of the total mineral production. Figures of total mineral production will be found on pages 5A—7A.

Gold, bound by a fixed price while costs of mining continued to rise, declined greatly in output from dry or siliceous ores and from

placers, and also as a by-product from ores of base metals whose prices decreased. These conditions have continued during the first half of 1920, and in June, 1920, only 42 per cent of the gold mines of the country were active. Legislation for stimulating the gold-mining industry has been proposed, but up to June, 1920, no definite action has been taken, and there is no prospect of marked improvement during the remainder of the year. Silver, although favored by a greatly increased price due to the strong Asiatic demand, is to so large an extent a by-product of base-metal and gold ores that its output decreased about 16 per cent. The price of silver began to decline early in 1920 and by June was as low as 84 cents an ounce; but it is expected that legislation fixing $1 as the price at which silver mined and refined in the United States will be purchased by the Government will raise the general market price again. Domestic production of platinum increased in 1919.

The base metals—copper, lead, and zinc—also declined in output and in value, although the production of much of the lead ore was favored by its relatively high silver content. The average prices of these metals also declined, and although they are still considerably higher than before the war, they are believed by many to have reached the minimum for the post-war period. The poor demand for these metals has continued well into 1920.

Iron ore declined 12 per cent and pig iron 21 per cent in output, owing in part to the poor demand for structural materials in the first part of 1919 but largely to the steel and coal strikes in the last part of the year.

Among the minor metals, the output of manganese was favored during the first six months of 1919 by war contracts; but when these terminated producers could find no market. The markets for tungsten, chromium, and other minor metals used for ferroalloys were also insignificant, and the stock already accumulated has brought production of these metals to a standstill. Production of antimony derived directly from antimony ore ceased in 1919, and that of quicksilver decreased about 35 per cent. Production of metallic magnesium also declined greatly. These conditions illustrate those of "war minerals" in general. Hope was expressed by some that enlarged production of at least a few of these minerals might continue after the war; but overproduction and present lack of demand have reduced most of them to their pre-war status, even before importation from the leading foreign sources has been reestablished. Tariffs on some of the metals of the "war minerals" group have been proposed, but none have been established, although a bill fixing a tariff on tungsten is pending in the Senate.

Production of coal followed the usual seasonal fluctuations for the first eight months of 1919, but at a slower rate than in either 1917 or 1918 because of slackened demand. An abnormal increase then followed in anticipation of the strike, and production rose to a record daily rate in the week of October 23, but during the strike, in November, it fell to one-third of normal. A quick recovery was made in December, and the rate of production in 1920 averaged very nearly that in 1917 and 1918 until April, when car shortage due chiefly to the switchmen's strike reduced output almost to the minimum of the low rate in 1919. As shown by the present high prices of spot coal (June, 1920), which exceed even those of 1917

before the passage of the Lever Act, the total output during the first half of 1920 has not been sufficient to meet present consumption and at the same time to replenish the stocks of coal that are ordinarily held by consumers but were seriously depleted by the coal strike.

Production of coke, especially beehive coke, underwent a great slump after the armistice was signed, keeping pace with the decline in production of pig iron. The most noteworthy feature of the coke industry was that, whereas the production of beehive coke declined 38 per cent, that of by-product coke declined only 3 per cent and for the first time exceeded that of beehive coke. The year 1919 may therefore be called a turning point in the history of coke manufacture in the United States.

Production of petroleum increased in 1919, but owing to greater consumption stocks were only slightly augmented, and in the last part of the year prices of crude oil were considerably advanced. Warnings by those in close touch with conditions governing production that new fields were not being discovered fast enough to offset depletion have had no effect in curtailing the demand for petroleum and its products, and the public is just coming to realize that consumption has for some time been exceeding combined domestic production and imports, and that petroleum, of which we were our allies' chief source of supply during the war and of which we were supposed to have an ample supply for both peace and war needs, is already a product in which we are deficient. Only curtailment in domestic usage and in exports, while American interests do their share of development work in foreign oil fields, will enable us to maintain a supply sufficient for our most vital needs and to establish reserves sufficient for any considerable number of years.

Natural gas apparently attained its maximum production in 1917, and the lower outputs in 1918 and 1919 are warnings which producers are heeding with a view to conservation of this fuel, two-thirds of the output of which is sold for industrial use. As 95 per cent of the world's output of natural gas is produced and consumed in the United States, its conservation will help to continue an advantage which the country has long enjoyed.

Structural materials have made a partial recovery from the depression during war time. Increased activity was not appreciable until the last half of the year, but the number of building permits issued was probably greater than in any other year. Scarcity of labor and high cost of supplies retarded actual operations, but Portland cement, the most widely used structural mineral product, increased 14 per cent in production and 21 per cent in shipments. Structural clay products and building stone as a whole also increased. Crushed stone increased 15 per cent, and gravel 21 per cent in quantity, thereby keeping pace with increased shipment of cement and with road building as well. Lime for building showed an increased production, and total lime increased about 4 per cent notwithstanding a general decline in chemical uses, some of which were abnormally large during the war. The outlook for structural materials in 1920 was very bright, but car shortages and labor troubles have already so delayed operations that marked increase in production is not to be expected. Uncertainty regarding costs of operating and

consequent selling prices is holding back building projects, and it is doubtful if any of these materials return to their normal status in 1920.

Of the fertilizers, phosphate rock showed a decrease of 9 per cent in production because of a strike in the Florida field that more than offset increases in other States. Production of potash also decreased, and several producers ceased operations, mainly because of accumulated stocks and expectation of renewed imports. Failure of imports to arrive, however, enabled producers to dispose of their stocks, and the first three months of 1920 showed production, mainly from saline lakes but in considerable part from Portland cement plants, at a rate exceeding the curtailed and intermittent production of 1919. Government nitrate plants, partly constructed when the war ended, have been the subject of some political and engineering discussion but have not advanced appreciably toward the producing stage. Production of agricultural lime increased about 9 per cent over 1918, and that of pulverized limestone increased 28 per cent.

Refractory materials as a whole declined with the decline of the iron and steel and other metallurgic industries. The magnesite situation, however, notwithstanding a decline of more than 30 per cent in production, has been encouraging, as imports expected in the first six months of 1919 have not yet been received, and domestic production has, therefore, recovered.

The unsettled state of the mineral industries in 1919 expressed in this résumé has continued during the first half of 1920. The data in the tables of this report show, however, that with the exception of the "war minerals" most commodities are below normal in output, and marked increases in production are therefore to be expected, but a steady return to normal output is being delayed by the slow readjustment of industries in general.

Owing to cooperation with the Bureau of the Census in the collection of statistics for 1919, the cooperation with State geological surveys and mining bureaus was less active than usual. The customary data have been furnished to the cooperating State organizations, but field work in collection of statistics, ordinarily carried on by members of the State organizations, was left to field agents of the Bureau of the Census.

All figures of imports and exports in this report were compiled by J. A. Dorsey, of the Geological Survey, from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, having been converted by Mr. Dorsey to the various units of measurement used in this report and arranged by him in their present form. The imports are those for the calendar year unless otherwise stated. Wherever exports are shown, unless otherwise specified, the figures represent domestic products and not foreign minerals reexported, and they also cover calendar years.

SUMMARY.

By Martha B. Clark.

GENERAL TABLES.

Mineral products of the United States in 1918 and 1919.[a]

Product.	1918		1919		Increase or decrease.		Percentage of increase or decrease.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
METALLIC.								
Aluminum.....pounds..	.....	$41,159,000	.....	$38,558,000	.....	− $2,601,000	.....	− 6
Antimonial lead [b].....short tons (2,000 pounds)..	18,570	2,826,350	13,874	1,513,968	− 4,696	− 1,312,382	−25	−46
Antimony [c].....do....	5,183	[c] 1,306,116	2,501	[c] 410,164	− 2,682	− 895,952	−52	−69
Bauxite.....long tons (2,240 pounds)..	605,721	3,447,992	376,566	2,201,747	− 229,155	− 1,246,245	−38	−36
Cadmium.....pounds..	127,164	188,203	99,939	121,926	− 27,225	− 66,277	−21	−35
Chromite.....long tons..	82,430	3,955,567	5,079	129,302	− 77,351	− 3,826,265	−94	−97
Copper,[d] sales value.....pounds..	1,908,533,595	471,408,000	1,286,419,329	239,274,000	−622,114,266	−232,134,000	−33	−49
Ferroalloys.....long tons..	750,868	115,433,943	391,901	46,290,145	− 358,967	− 69,143,798	−48	−60
Gold [e].....troy ounces..	3,320,784	68,646,700	2,918,628	60,333,400	− 402,156	− 8,313,300	−12	−12
Iron:								
Ore [f].....long tons..	72,021,202	[f] 244,368,147	56,371,167	[f] 197,296,282	− 15,650,035	− 47,071,865	−22	−19
Pig.....do....	38,230,440	1,180,759,565	30,130,231	775,915,043	− 8,100,209	−404,844,522	−21	−34
Lead (refined),[d] sales value.....short tons..	539,905	76,667,000	424,433	44,990,000	− 115,472	− 31,677,000	−21	−41
Manganese ore (35 per cent or more Mn).....long tons..	305,869	8,240,386	55,322	1,796,863	− 250,547	− 6,443,523	−82	−78
Manganiferous ore (5 to 35 per cent Mn).....do..	1,170,462	5,635,579	433,733	1,552,492	− 736,729	− 4,083,087	−63	−72
Nickel,[g] value at New York City.....short tons..	441	401,000	511	434,485	+ 70	+ 33,485	+16	+ 8
Platinum and allied metals (value at New York City) .....troy ounces..	59,753	6,417,980	45,109	5,614,335	− 14,644	− 803,645	−25	−13
Quicksilver (value at San Francisco) flasks (75 pounds net)..	32,883	3,863,752	21,415	1,933,560	− 11,468	− 1,930,192	−35	−50
Silver.....troy ounces..	67,810,139	66,485,129	56,682,445	63,533,652	− 11,127,694	− 2,951,477	−16	− 4
Tin (metallic equivalent).....short tons..	69	118,500	56	73,400	− 13	− 45,100	−19	−38
Titanium ore (rutile).....do....	261	39,150	102	20,400	− 159	− 18,750	−61	−48
Tungsten ore (60 per cent concentrates).....do....	5,061	7,049,300	327	353,900	− 4,734	− 6,695,400	−94	−95
Uranium and vanadium minerals.....do....	18,860	957,000	14,509	1,630,900	− 4,351	+ 673,900	−23	+70
Zinc,[d] sales value.....do....	492,405	89,618,000	452,272	66,032,000	− 40,133	− 23,586,000	− 8	−26
Total value of metallic products (approximate).....	.....	2,153,318,000	.....	1,352,304,000	.....	−801,014,000	.....	−37

[a] Attention is called to the fact that in this general statement certain of the figures represent shipments rather than quantity mined. The reader is referred to the following sections on the various mineral products for more detailed information in this regard than it seems practicable to give here.

[b] From both domestic and foreign ores.

[c] From all sources. Values excluded from metallic totals as the values of the antimony contained in antimonial lead are included in the antimonial lead values, and the remainder under last item ("Unspecified").

[d] Product from domestic ores only.

[e] Value, $20.671834625323 an ounce.

[f] Value not included in total value.

[g] By-product in electrolytic copper refining; also produced from cobalt ores in 1919.

Mineral products of the United States in 1918 and 1919—Continued.

Product.	1918		1919		Increase or decrease.		Percentage of increase or decrease.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
NONMETALLIC.								
Arsenious oxide.....short tons..	6,323	$1,213,000	6,029	$1,181,684	− 294	− $31,316	− 5	− 3
Asbestos.....do....	1,002	124,687	1,361	251,265	+ 359	+ 126,578	+36	+102
Asphalt.....do....	[a] 664,757	[a] 9,577,349	702,973	9,410,361	+ 38,216	− 166,988	+ 6	− 2
Barytes (crude).....do....	155,368	1,044,905	209,330	1,727,822	+ 53,962	+ 682,917	+35	+ 65
Borates.....do....	88,794	2,263,230	66,146	1,380,000	− 22,648	− 883,230	−26	− 39
Bromine.....pounds..	1,727,156	970,099	1,854,971	1,234,969	+ 127,815	+ 264,870	+ 7	+ 27
Calcium-magnesium chloride.....short tons..	26,624	503,452	26,123	321,596	− 501	− 181,856	− 2	− 36
Cement.....barrels (376 pounds net)..	71,348,474	[a] 113,717,616	86,141,488	147,318,398	+ 14,793,014	+ 33,600,782	+21	+ 30
Clay:								
Products.....	.....	[a] 220,573,493	.....	275,774,298	.....	+ 55,200,805	.....	+ 25
Raw[b].....short tons..	2,976,361	[b] 8,332,641	2,275,100	[b] 7,090,631	− 701,261	− 1,242,010	−24	− 15
Coal:								
Bituminous[c].....do....	579,385,820	1,491,809,940	465,860,058	1,160,616,013	−113,525,762	−331,193,927	−20	− 22
Pennsylvania anthracite.....long tons..	88,237,575	336,480,347	78,653,751	364,926,950	− 9,583,824	+ 28,446,603	−11	+ 8
Coke[b].....short tons..	56,478,372	[b] 382,324,368	44,180,557	[b] 258,339,740	− 12,297,815	−123,984,628	−22	− 32
Diatomaceous (infusorial) earth and tripoli.....do....	[d] 22,947	[d] 224,801	66,934	713,501	(e)	(e)	(e)	(e)
Emery (also corundum in 1918).....do....	10,422	112,878	2,601	23,203	− 7,821	− 89,675	−75	− 79
Feldspar.....do....	99,120	674,346	71,054	585,200	− 28,066	− 89,146	−28	− 13
Fluorspar.....do....	263,817	5,465,481	138,290	3,525,574	− 125,527	− 1,939,907	−48	− 35
Fuller's earth.....do....	84,468	1,146,354	106,145	1,998,829	+ 21,677	+ 852,475	+26	+ 74
Garnet for abrasive purposes.....do....	4,696	248,161	4,944	310,131	+ 248	+ 61,970	+ 5	+ 25
Gems and precious stones.....	.....	106,523	.....	111,763	.....	+ 5,240	.....	+ 5
Graphite:								
Amorphous.....short tons..	6,560	69,455	3,379	47,716	− 3,181	− 21,739	−48	− 31
Crystalline.....pounds..	12,861,839	1,454,799	8,086,191	731,141	− 4,775,648	− 723,658	−37	− 50
Grindstones and pulpstones.....short tons..	65,339	1,776,282	46,865	1,336,015	− 18,474	− 440,267	−28	− 25
Gypsum.....do....	2,057,015	11,470,854	2,420,163	15,727,907	+ 363,148	+ 4,257,053	+18	+ 37
Lime.....do....	3,206,016	26,808,909	3,330,347	29,448,553	+ 124,331	+ 2,639,644	+ 4	+ 10
Magnesite (crude).....do....	231,605	1,812,601	156,226	1,248,415	− 75,379	− 564,186	−33	− 31
Mica:								
Scrap.....do....	2,292	33,130	3,258	58,084	+ 966	+ 24,954	+42	+ 75
Sheet.....pounds..	1,644,200	731,810	1,545,709	483,567	− 98,491	− 248,243	− 6	− 34
Millstones.....	.....	92,514	.....	66,972	.....	− 25,542	.....	− 28
Mineral paints:								
Natural pigments[f].....short tons..	(f)	(f)	(f)	(f)	(f)	(f)	(f)	(f)
Zinc and lead pigments[g].....do....	135,746	26,464,590	155,648	25,810,671	+ 19,902	− 653,919	+15	− 2
Mineral waters.....gallons sold..	40,709,722	4,533,001	38,697,280	4,880,186	− 2,012,442	+ 347,185	− 5	+ 8
Natural gas.....M cubic feet..	721,000,959	153,553,560	739,915,781	132,888,300	+ 18,914,822	− 20,665,260	+ 3	− 13
Natural-gas gasoline.....gallons..	282,535,550	50,363,535	351,535,026	64,196,763	+ 68,999,476	+ 13,833,228	+24	+ 27
Oilstones, etc.....short tons..	1,010	189,033	1,463	235,943	+ 453	+ 46,910	+45	+ 25
Peat.....do....	107,261	1,047,243	69,197	705,532	− 38,064	− 341,711	−35	− 33

Petroleum ..... barrels (42 gallons)	355,927,716	703,943,961	378,367,000	759,866,000	+ 22,439,284	+ 55,922,039	+ 6	+ 8
Phosphate rock ..... long tons	2,490,760	8,214,463	2,271,983	11,591,268	− 218,777	+ 3,376,805	− 9	+ 41
Potash (K_2O) ..... short tons	38,580	15,839,618	45,728	11,271,269	+ 7,148	− 4,568,349	+19	− 29
Pumice ..... do	30,637	91,178	36,051	116,835	+ 5,414	+ 25,657	+18	+ 28
Pyrites ..... long tons	464,494	2,644,515	420,647	2,558,172	− 43,847	− 86,343	− 9	− 3
Salt ..... short tons	7,238,744	26,940,361	6,882,902	27,074,694	− 355,842	+ 134,333	− 5	+ .5
Sand:								
Glass ..... do	2,172,887	4,209,728	1,827,409	3,593,371	− 345,478	− 616,357	−16	− 15
Molding, building, etc., and gravel ..... do	59,651,539	33,717,351	68,748,998	42,358,185	+ 9,097,459	+ 8,640,834	+15	+ 26
Sand-lime brick ..... thousands	98,399	883,929	146,947	1,705,163	+ 48,548	+ 821,234	+49	+ 93
Silica (quartz) ..... short tons	71,740	259,330	63,332	373,571	− 8,408	+ 114,241	−12	+ 44
Slate		[h] 4,038,770		6,030,648		[e]		[e]
Stone ..... short tons	68,563,360	82,700,430	65,539,000	96,709,143	− 3,024,360	+ 14,008,713	− 4	+ 17
Sulphur ..... long tons	1,266,709	27,868,000	678,257	10,252,000	− 588,452	− 17,616,000	−46	− 63
Sulphuric acid (60° Baumé) from copper and zinc smelters ..... short tons	[i]	[i]	[j] 811,509	[j] 7,526,400	[i]	[i]	[i]	[i]
Talc and soapstone ..... do	208,307	2,681,019	184,843	2,352,675	− 23,464	− 328,344	−11	− 12
Thorium minerals (monazite) ..... pounds			[k]	[k]	[k]	[k]	[k]	[k]
Total value of nonmetallic products (approximate)		3,380,690,000		3,232,657,000		[l] 148,033,000		[l] 4
SUMMARY.								
Total value of metallic products		2,153,318,000		1,352,304,000		−801,014,000		− 37
Total value of nonmetallic products (exclusive of mineral fuels)		644,539,000		750,163,000		+ [l] 105,624,000		+ [l] 16
Total value of mineral fuels		2,736,151,000		2,482,494,000		−253,657,000		− 9
Total value of "unspecified" (metallic and nonmetallic) products (partly estimated) [m]		[m] 6,700,000		3,630,000		− 3,070,000		− 46
Grand total approximate value of all mineral products		5,540,708,000		4,588,591,000		[l] 952,117,000		[l] 17

[a] Revised figures.
[b] Value not included in total value.
[c] Includes brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
[d] Exclusive of considerable production for special uses which is included under last item ("Unspecified"). Survey not at liberty to publish figures.
[e] Figures for 1918 and 1919 not comparable.
[f] Canvass discontinued after 1915. Value of iron ore sold for paint included under last item ("Unspecified").
[g] Sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.
[h] Exclusive of value of slate granules which is included under last item ("Unspecified"). Survey not at liberty to publish figures.
[i] No canvass for 1918.
[j] According to Bureau of the Census. Figures represent production, the value having been partly estimated by Geological Survey to cover acid consumed by producer as well as that sold.
[k] Value included under last item ("Unspecified"). Survey not at liberty to publish figures.
[l] No canvass for 1918. If the value of this smelter acid were excluded from the 1919 totals, the decrease in nonmetallic products would be $155,559,000 (4.6 per cent instead of 4.4 per cent); the increase in nonmetallic products, other than mineral fuels, $98,098,000 (15.2 per cent instead of 16.4 per cent); and the decrease in value of all mineral products, $959,643,000 (17.3 per cent instead of 17.2 per cent).
[m] Includes in 1919 products as follows: Antimony other than content of antimonial lead, bismuth, cadmium sulphide ($37,436), chats ($550,300), chert, cobalt ($122,452), columbite ($90), flint lining for tube mills, ilmenite, iron ore sold for paint ($84,630), iron ore sold for magnets, lithium minerals ($115,000), magnesium ($247,302), calcareous marl ($327,294), greensand marl, molybdenum ($341,814), monazite, pebbles for grinding ($72,222), selenium ($125,966), silica sand and sandstone, finely ground ($288,890), sodium salts (carbonate, bicarbonate, and sulphate) from natural sources ($608,240), tellurium, and an estimate of the value of miscellaneous mineral products, statistics for which are not collected annually by the Survey.

Comparison of mineral production of the United States in 1913 and 1919 with values for 1919 recalculated on basis of average prices in 1913.

Product.	1913			1919		
	Quantity.	Value.	Average price.	Quantity.	Value.	Value at 1913 average price.
METALLIC.						
Antimonial lead....short tons..	16,665	$1,591,854	$95.52	13,874	$1,513,968	$1,325,000
Antimony.....do....	2,508	429,363	171.20	2,501	410,164	428,000
Bauxite.....long tons..	210,241	997,698	4.75	376,566	2,201,747	1,789,000
Cadmium.....pounds..	54,198	41,838	.77	99,939	121,926	77,000
Chromite.....long tons..	255	2,854	11.19	5,079	129,302	57,000
Copper.....pounds..	1,224,484,098	189,795,035	.155	1,286,419,329	239,274,000	199,395,000
Ferroalloys.....long tons..	296,207	13,015,362	43.94	391,901	46,290,145	17,220,000
Iron:						
Ore.....do....	59,643,098	130,905,558	2.19	56,371,167	197,296,282	123,453,000
Pig.....do....	30,388,935	458,342,345	15.08	30,130,231	775,915,043	454,364,000
Lead (refined).....short tons..	411,878	36,245,264	88.00	424,433	44,990,000	37,350,000
Manganese ore.....long tons..	4,048	40,480	10.00	55,322	1,796,863	553,000
Nickel.....short tons..	241	79,393	329.43	511	434,485	168,000
Platinum and allied metals, ...troy ounces..	1,034	46,530	45.00	45,109	5,614,335	2,030,000
Quicksilver.....flasks..	20,213	813,171	40.23	21,415	1,933,560	862,000
Silver.....troy ounces..	66,801,500	40,348,100	.60	56,682,445	63,533,652	34,009,000
Titanium ore(rutile).short tons..	305	49,000	160.66	102	20,400	16,000
Tungsten ore.....do....	1,537	672,118	437.29	327	353,900	143,000
Zinc.....do....	337,252	37,772,224	112.00	452,272	66,032,000	50,654,000
NONMETALLIC.						
Asbestos.....short tons..	1,100	11,000	10.00	1,361	251,265	14,000
Asphalt.....do....	529,190	5,282,370	9.98	702,973	9,410,361	7,016,000
Barytes (crude).....do....	45,298	156,275	3.45	209,330	1,727,822	722,000
Borates.....do....	58,051	1,491,530	25.69	66,146	1,380,000	1,699,000
Bromine.....pounds..	572,400	115,436	.20	1,854,971	1,234,969	371,000
Calcium chloride...short tons..	19,611	130,030	6.63	26,123	321,596	173,000
Cement.....barrels..	89,541,348	89,550,527	1.00	86,141,488	147,318,398	86,141,000
Clay (raw).....short tons..	2,647,989	4,180,459	1.58	2,275,100	7,090,631	3,595,000
Coal:						
Bituminous.....do....	478,435,297	565,234,952	1.18	465,860,058	1,160,616,013	549,715,000
Pennsylvania anthracite, ...long tons..	81,718,680	195,181,127	2.39	78,653,751	364,926,950	187,982,000
Emery.....short tons..	957	4,785	5.00	2,601	23,203	13,000
Fluorspar.....do....	115,580	736,286	6.37	138,290	3,525,574	881,000
Fuller's earth.....do....	38,594	369,750	9.58	106,145	1,998,829	1,017,000
Garnet for abrasive purposes, ...short tons..	5,308	183,422	34.56	4,944	310,131	171,000
Graphite:						
Amorphous.....do....	2,243	39,428	17.58	3,379	47,716	59,000
Crystalline.....pounds..	5,064,727	254,328	.05	8,086,191	731,141	404,000
Gypsum.....short tons..	2,599,508	6,774,822	2.61	2,420,163	15,727,907	6,317,000
Lime.....do....	3,595,390	14,648,362	4.07	3,330,347	29,448,553	13,555,000
Magnesite (crude).....do....	9,632	77,056	8.00	156,226	1,248,415	1,250,000
Mineral waters....gallons sold..	57,867,399	5,631,391	.10	38,697,280	4,880,186	3,870,000
Natural gas.....M cu. ft..	581,898,239	87,846,677	.15	739,915,781	132,888,300	110,987,000
Peat.....short tons..	33,260	197,200	5.93	69,197	705,532	410,000
Petroleum.....barrels..	248,446,230	237,121,388	.95	378,367,000	759,866,000	359,449,000
Phosphate rock.....long tons..	3,111,221	11,796,231	3.79	2,271,983	11,591,268	8,611,000
Pyrites.....do....	341,338	1,286,084	3.77	420,647	2,558,172	1,586,000
Salt.....short tons..	4,815,902	10,123,139	2.10	6,882,902	27,074,694	14,454,000
Sand:						
Glass.....do....	1,791,800	1,895,991	1.06	1,827,409	3,593,371	1,937,000
Molding, building, etc., and gravel...short tons..	77,764,049	22,321,517	.29	68,748,998	42,358,185	19,937,000
Sand-lime brick....thousands..	189,659	1,238,325	6.53	146,947	1,705,163	960,000
Sulphur.....long tons..	319,333	5,617,000	17.59	678,257	10,252,000	11,931,000
Percentage of increase in 1919 value as reported over value at 1913 average prices for products shown above:						
Metallic.....					57	
Nonmetallic.....					97	
Metallic and nonmetallic...					81	

Total value of mineral products of the United States from 1880 to 1919.

Year.	Metallic.		Nonmetallic.		Unspecified (metallic and nonmetallic).	Total.	
	Value.	Percentage of increase or decrease.	Value.	Percentage of increase or decrease.		Value.	Percentage of increase or decrease.
1880	$187,881,000	.....	$173,582,000	.....	$6,000,000	$367,463,000	.....
1881	189,413,000	+ 0.8	207,207,000	+19	6,500,000	403,120,000	+10
1882	215,820,000	+ 4	230,786,000	+11	6,500,000	453,106,000	+12
1883	197,881,000	−18	243,680,000	+ 6	6,500,000	448,061,000	− 1
1884	180,284,000	− 9	221,756,000	− 9	5,000,000	407,040,000	− 9
1885	172,218,000	− 4	242,333,000	+ 9	5,000,000	419,551,000	+ 3
1886	204,400,000	+19	250,995,000	+ 4	790,000	456,185,000	+ 9
1887	240,791,000	+18	294,057,000	+17	785,000	535,633,000	+17
1888	242,010,000	+ .5	310,889,000	+ 6	900,000	553,799,000	+ 3
1889	250,325,000	+ 3	291,004,000	− 6	997,000	542,326,000	− 2
1890	303,440,000	+21	310,995,000	+ 7	994,000	615,429,000	+13
1891	280,485,000	− 8	319,364,000	+ 3	1,000,000	600,849,000	− 2
1892	283,715,000	+ 1	337,517,000	+ 6	1,000,000	622,232,000	+ 4
1893	223,154,000	−21	321,339,000	− 5	1,000,000	545,493,000	−12
1894	186,835,000	−16	362,410,000	+13	1,000,000	550,245,000	+ .9
1895	248,033,000	+33	393,658,000	+ 9	1,000,000	642,691,000	+17
1896	252,075,000	+ 2	387,966,000	− 1	1,000,000	641,041,000	− .3
1897	269,934,000	+ 7	380,678,000	− 2	1,000,000	651,612,000	+ 2
1898	308,247,000	+14	417,795,000	+10	1,000,000	727,042,000	+12
1899	483,521,000	+57	525,575,000	+26	1,000,000	1,010,096,000	+39
1900	513,732,000	+ 6	594,204,000	+13	1,000,000	1,108,936,000	+10
1901	493,314,000	− 4	660,764,000	+11	1,000,000	1,155,078,000	+ 4
1902	604,517,000	+23	722,434,000	+ 9	1,000,000	1,327,951,000	+15
1903	588,753,000	− 3	905,628,000	+25	1,000,000	1,495,381,000	+13
1904	501,114,000	−15	857,667,000	− 5	400,000	1,359,181,000	− 9
1905	702,585,000	+40	920,780,000	+ 7	400,000	1,623,765,000	+19
1906	886,180,000	+26	1,014,500,000	+10	200,000	1,900,880,000	+17
1907	904,108,000	+ 2	1,165,376,000	+15	86,000	2,069,570,000	+ 9
1908	550,768,000	−39	1,040,761,000	−11	244,000	1,591,773,000	−23
1909	754,944,000	+37	1,131,866,000	+ 9	297,000	1,887,107,000	+19
1910	749,879,000	− .7	1,237,668,000	+ 9	297,000	1,987,844,000	+ 5
1911	680,907,000	− 9	1,242,942,000	+ .4	232,000	1,924,081,000	− 3
1912	862,008,000	+27	1,375,420,000	+11	366,000	2,237,794,000	+16
1913	878,869,000	+ 2	1,554,298,000	+13	378,000	2,433,545,000	+ 9
1914	686,639,000	−22	1,424,063,000	− 8	470,000	2,111,172,000	−13
1915	991,730,000	+44	1,400,484,000	− 2	2,430,000	2,394,644,000	+13
1916	1,620,745,000	+63	1,884,413,000	+35	3,281,000	3,508,439,000	+47
1917	2,086,234,000	+29	2,900,462,000	+54	5,800,000	4,992,496,000	+42
1918	2,153,318,000	+ 3	3,380,690,000	+17	6,700,000	5,540,708,000	+11
1919	1,352,304,000	−37	3,232,657,000	− 4	3,630,000	4,588,591,000	−17
Grand total..	23,483,110,000	.....	34,870,663,000	.....	78,177,000	58,431,950,000	.....

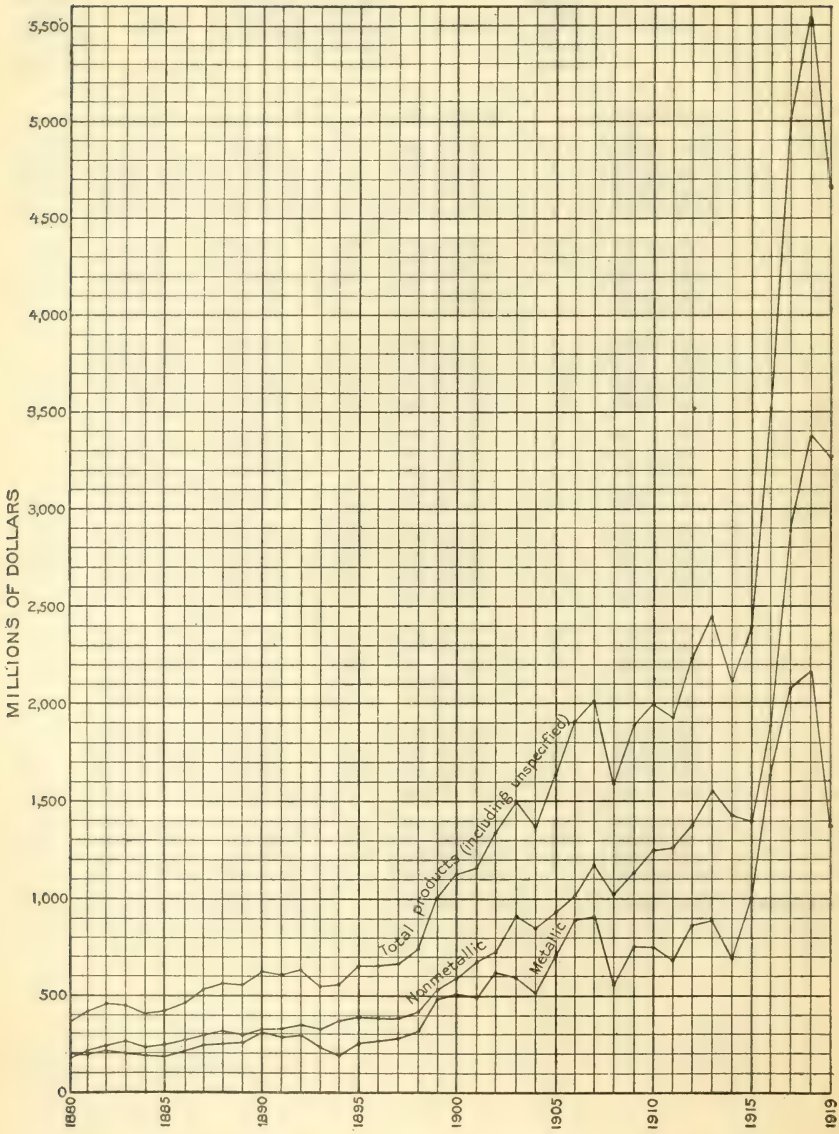

FIGURE 1.—Value of mineral products of the United States, 1880–1919.

Mineral products of the United States and leading producing States in 1919.

Mineral.	Principal producing States in order of value in 1919.
Aluminum	New York, North Carolina, Tennessee.
Antimonial lead	Not separable by States.
Arsenious oxide	Not separable by States.
Asbestos	Arizona, Wyoming, Maryland, Georgia.
Asphalt	California, Texas, Oklahoma, Illinois.
Barytes (crude)	Georgia, Missouri, Tennessee, Kentucky.
Bauxite	Arkansas, Georgia, Alabama, Tennessee.
Borates	California.
Bromine	Michigan, West Virginia, Ohio.
Cadmium	Not separable by States.
Calcium-magnesium chloride	Michigan, Ohio, West Virginia, California.
Cement	Pennsylvania, Indiana, Missouri, California.
Chromite	California, Wyoming, Oregon, Maryland.
Clay:	
Products	Ohio, Pennsylvania, New Jersey, Illinois.
Raw	Pennsylvania, New Jersey, Missouri, Georgia.
Coal:	
Bituminous	Pennsylvania, West Virginia, Illinois, Ohio.
Pennsylvania anthracite	Pennsylvania.
Coke	Pennsylvania, Ohio, Indiana, Alabama.
Copper	Arizona, Michigan, Montana, Utah.
Diatomaceous (infusorial) earth and tripoli.	California, Illinois, Pennsylvania, Oregon.
Emery	New York, Virginia.
Feldspar	Maine, Connecticut, North Carolina, New York.
Ferroalloys	Pennsylvania, Illinois, New York, Alabama.
Fluorspar	Illinois, Kentucky, Colorado, New Mexico.
Fuller's earth	Florida, Texas, Georgia, Alabama.
Garnet for abrasive purposes	New York, New Hampshire, North Carolina.
Gems and precious stones	Montana, Maine, Arizona, Nevada.
Gold	California, Colorado, Alaska, South Dakota.
Graphite	New York, Alabama, Rhode Island, Pennsylvania.
Grindstones and pulpstones	Ohio, West Virginia, Michigan.
Gypsum	New York, Iowa, Michigan, Ohio.
Iron:	
Ore	Minnesota, Michigan, Alabama, New York.
Pig	Pennsylvania, Ohio, Illinois, Alabama.
Lead	Missouri, Idaho, Utah, Oklahoma.
Lime	Pennsylvania, Ohio, Virginia, Missouri.
Magnesite (crude)	Washington, California.
Manganese ore	Montana, California, Colorado, Virginia.
Manganiferous ore	Minnesota, Nevada, Colorado, Michigan.
Mica	North Carolina, New Hampshire, Virginia, Georgia.
Millstones	North Carolina, Virginia, New York, Pennsylvania.
Mineral paints:	
Natural pigments	Canvass discontinued.
Zinc and lead pigments	Pennsylvania, Kansas, Illinois, Wisconsin.
Mineral waters	Wisconsin, New York, California, Maine.
Natural gas	West Virginia, Pennsylvania, Ohio, Oklahoma.
Natural-gas gasoline	Oklahoma, West Virginia, California, Pennsylvania.
Nickel	Not separable by States.
Oilstones, etc	Arkansas, Indiana, New Hampshire, Ohio.
Peat	New Jersey, Illinois, Florida, Massachusetts.
Petroleum	Oklahoma, Texas, California, Kansas.
Phosphate rock	Florida, Tennessee, South Carolina, Kentucky.
Platinum and allied metals	California, Alaska, Nevada, Oregon.
Potash (K_2O)	Nebraska, California, Utah, Colorado.
Pumice	Kansas, California, Nebraska.
Pyrites	Virginia, California, New York, Georgia.
Quicksilver	California, Texas, Nevada, Oregon.
Salt	Michigan, New York, Kansas, Ohio.
Sand and gravel	Pennsylvania, Ohio, Illinois, Indiana.
Sand-lime brick	Michigan, Minnesota, Wisconsin, New York.
Silica (quartz)	Connecticut, Maryland, Tennessee, Wisconsin.
Silver	Montana, Utah, Nevada, Colorado.
Slate	Pennsylvania, Vermont, New York, Maine.
Stone	Pennsylvania, Vermont, Ohio, New York.
Sulphur	Louisiana, Texas, Nevada.
Sulphuric acid from copper and zinc smelters	Illinois, Pennsylvania, Tennessee, West Virginia.
Talc and soapstone	New York, Vermont, Virginia, California.
Tin	Alaska.
Titanium ore (rutile)	Virginia.
Tungsten ore	California, Colorado, Arizona.
Uranium and vanadium minerals	Colorado, Utah, Wyoming.
Zinc	Oklahoma, New Jersey, Montana, Kansas.

Mineral-producing States and their leading mineral products in 1919.

State.	Principal mineral products in order of value in 1919.
Alabama	Coal, iron ore, clay products, cement.
Alaska	Gold, copper, silver, coal.
Arizona	Copper, silver, gold, lead.
Arkansas	Coal, bauxite, clay products, natural gas.
California	Petroleum, gold, natural gas, cement.
Colorado	Coal, gold, silver, zinc.
Connecticut	Clay products, stone, lime, sand and gravel.
Delaware	Clay products, stone, sand and gravel.
District of Columbia	Clay products, stone, sand-lime brick, mineral waters.
Florida	Phosphate rock, fuller's earth, clay products, stone.
Georgia	Clay products, stone, barytes, cement.
Idaho	Lead, silver, zinc, gold.
Illinois	Coal, petroleum, clay products, cement.
Indiana	Coal, cement, clay products, stone.
Iowa	Coal, clay products, cement, gypsum.
Kansas	Petroleum, coal, zinc, cement.
Kentucky	Coal, petroleum, clay products, stone.
Louisiana	Petroleum, sulphur, natural gas, natural-gas gasoline.
Maine	Stone, lime, clay products, mineral waters.
Maryland	Coal, cement, clay products, sand and gravel.
Massachusetts	Stone, clay products, sand and gravel, lime.
Michigan	Iron ore, copper, salt, cement.
Minnesota	Iron ore, clay products, cement, stone.
Mississippi	Clay products, sand and gravel, mineral waters, stone.
Missouri	Lead, coal, clay products, cement.
Montana	Copper, silver, zinc, coal.
Nebraska	Potash (K_2O), clay products, sand and gravel, cement.
Nevada	Copper, silver, gold, lead.
New Hampshire	Stone, clay products, mica, sand and gravel.
New Jersey	Clay products, zinc, cement, sand and gravel.
New Mexico	Coal, copper, silver, gold.
New York	Clay products, cement, salt, stone.
North Carolina	Clay products, stone, mica, sand and gravel.
North Dakota	Coal, clay products, sand and gravel, mineral waters.
Ohio	Coal, clay products, petroleum, natural gas.
Oklahoma	Petroleum, natural-gas gasoline, zinc, natural gas.
Oregon	Gold, stone, sand and gravel, cement.
Pennsylvania	Coal, cement, clay products, petroleum.
Rhode Island	Stone, clay products, graphite, mineral waters.
South Carolina	Clay products, stone, phosphate rock, sand and gravel.
South Dakota	Gold, sand and gravel, stone, silver.
Tennessee	Coal, clay products, zinc, phosphate rock.
Texas	Petroleum, natural gas, sulphur, coal.
Utah	Copper, silver, coal, lead.
Vermont	Stone, slate, talc, lime.
Virginia	Coal, clay products, lime, stone.
Washington	Coal, cement, clay products, magnesite.
West Virginia	Coal, petroleum, natural gas, clay products.
Wisconsin	Zinc, iron ore, stone, sand and gravel.
Wyoming	Petroleum, coal, natural-gas gasoline, iron ore.

Prices of silver, copper, lead, and zinc, 1910–1919.

Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]	Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]
	Troy oz.	*Pound.*	*Pound.*	*Pound.*		*Troy oz.*	*Pound.*	*Pound.*	*Pound.*
1910	$0.54	$0.127	$0.044	$0.054	1915	$0.507	$0.175	$0.047	$0.124
1911	.53	.125	.045	.057	1916	.658	.246	.069	.134
1912	.615	.165	.045	.069	1917	.824	.273	.086	.102
1913	.604	.155	.044	.056	1918	*e*.98	.247	.071	.091
1914	.553	.133	.039	.051	1919	1.12	.186	.053	.073

a Average price furnished by Bureau of the Mint.

b For 1910–1915, U. S. Geological Survey computation for electrolytic copper based on quotations by technical journals. For 1916 and later years, average price, all marketable grades.

c For 1910–1915, New York price, U. S. Geological Survey computation from daily market spot quotations. For 1916, from outside spot quotations at New York. For 1917 and later years, average price, all grades.

d For 1910–1914, St. Louis price, U. S. Geological Survey computation from daily market spot quotations. For 1915 and later years, average price, all grades.

e Price given by Bureau of Mint early in 1919 as the approximate average selling price of all silver sold in 1918 was $1 a troy ounce, and this price was used by the Geological Survey in computing value of mine production of silver in State tables, pp. 126A to 153A. The price of 98 cents a troy ounce, later given by the Mint, has been used in computing value of smelter output of silver in all Mint-Survey cooperative tables.

IMPORTS AND EXPORTS.[1]

Value of mineral products imported for consumption in the United States and of mineral products exported from the United States, 1918 and 1919.

Metallic products.

Product.	1918	1919
IMPORTS.		
Aluminum:		
Crude, plates, sheets, leaf, wire, utensils, and manufactures	$554,586	$4,568,595
Aluminum salts	18,519	21,877
Antimony (crude and ore)	177,731	54,477
Antimony (metal or regulus)	3,178,877	1,040,789
Antimony (oxide and salts of)	11,904	9,501
Bauxite, crude	14,791	36,820
Bismuth	277,273	55,179
Brass, fit only for remanufacture	1,773,789	2,157,043
Chromic iron ore	2,892,825	1,381,497
Chromium salts	3,049	4,271
Cobalt, and cobalt ore and zaffer	628,099	144,282
Cobalt, oxide of	291,699	184,751
Copper in ore, matte, ingots, manufactures	131,379,189	88,859,845
Copper sulphate of, or blue vitriol	5	2,825
Ferroalloys:		
Chrome or chromium, and ferrochrome or ferrochromium	----------	100,404
Ferrophosphorus	1,055	13,388
Ferrovanadium	----------	24,923
Molybdenum and ferromolybdenum	19,280	40,759
Titanium and ferrotitanium	10	3,317
Tungsten or wolfram metal and ferrotungsten	8	287,981
Iron ore	3,464,304	2,385,689
Iron in pigs:		
Ferromanganese	4,258,745	4,283,541
Ferrosilicon	424,932	629,362
Spiegeleisen (including kentledge)	228,338	1,018
All other	15,828	1,651,185
Lead in ore, base bullion, pigs, sheets, etc	618,191	1,760,209
Manganese, oxide, and ore of	15,095,867	11,229,184
Nickel, in ore, matte, sheets, strips, and manufactures	11,632,797	8,424,262
Oxides	3,221	324
Ores (other steel hardening):		
Molybdenum	[a] 123,924	77,572
Titanium	[a] 221	----------
Uranium—radium	[a] 4,840	----------
Vanadium	[a] 5,333	67,846
Zirconium	[a] 77,250	332
All other	[a] 5,637	4,227
Platinum, and allied metals:		
Ores of platinum, and unmanufactured	4,949,855	5,229,309
Vases, retorts, all other	8,597	17,213
Iridium, osmium, palladium, rhodium, and ruthenium	163,135	1,388,522
Osmiridium	46,321	112,403
Quicksilver	533,622	791,226
Selenium	----------	25,866
Tin, bars, blocks, pigs	93,144,218	50,890,019
Scrap (tin plate)	119,591	91,281
Tungsten-bearing ore	11,552,218	6,261,190
Type metal	35,938	816,642
Uranium salts, and oxide, including some radium salts	274	12,960
Zinc:		
Ore[b]	291,449	119,540
Blocks or pigs	2,897	2,284
Old worn out, fit only to be remanufactured	2,056	2,216
Dust	3,552	5,753
Sheets	29	249
All other	331	1,258
	288,036,200	195,275,206
Decrease in 1919	----------	92,760,994
Percentage of decrease in 1919	----------	32
EXPORTS.		
Aluminum:		
Ingots, metals and alloys	7,478,149	1,495,659
Plates and sheets	1,500,903	249,237
All other manufactures	1,890,336	2,145,430
Bauxite concentrates	1,523,688	1,372,094
Brass, scrap and old	799,318	176,028

[a] Six months, July to December. Not separately classified prior to July, 1918.
[b] Exclusive of zinc for refining in bonded works for export.

[1] Compiled by Jas. A. Dorsey from records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

Value of mineral products imported for consumption in the United States and of mineral products exported from the United States, 1918 and 1919—Continued.

Metallic products—Continued.

Product.	1918	1919
EXPORTS—continued.		
Copper:		
Ore	$578,165	$95,930
Concentrates, matte, and regulus	211,392	32,611
Unrefined, black blister, in pigs, bars, etc	3,825,606	360,089
Refined copper in ingots, pigs, bars, etc	178,831,041	95,636,546
Composition metal	60,128	110,032
Old and scrap	60,733	74,104
Pipes and tubes	1,845,222	2,206,895
Plates and sheets	5,677,408	4,090,491
Wire, except insulated	4,750,942	14,810,357
All other manufactures	5,286,143	4,557,812
Copper, sulphate of (blue vitriol)	1,395,946	928,291
Iron:		
Ore	5,535,090	4,308,746
Pig:		
Ferromanganese	806,087	445,840
Ferrosilicon	443,456	145,310
All other	10,327,178	11,722,033
Ferrovanadium	1,774,062	95,560
Tungsten and ferrotungsten	2,545,087	113,276
Scrap and old, fit only for remanufacture	63,626	717,325
Lead:		
Pigs, bars, etc	5,889,381	1,471,256
Other manufactures of	1,824,126	2,155,392
Nickel, nickel oxide, and matte	6,927,041	1,697,544
Manufactures of	2,152,692	2,412,287
Platinum:		
Unmanufactured	13,511	75,066
Manufactured	23,562	54,529
Quicksilver	338,620	817,328
Tin, in pigs, bars	31,952	415,921
Zinc:		
Ore	2,480	.....
Dross	2,238,913	739,295
In pigs, slabs, etc	12,469,622	17,524,153
Rolled in sheets, strips, etc	4,566,756	5,212,002
All other manufactures	722,621	538,133
	274,410,983	179,002,602
Decrease in 1919	.....	95,408,381
Percentage of decrease in 1919	.....	35

Nonmetallic products.

IMPORTS.		
Arsenic, sulphide, etc	$1,281,812	$941,181
Sheep dip and London purple	23,538	12,360
Asbestos:		
Unmanufactured	6,337,608	7,369,685
Manufactured	3,132	187,816
All other	23,154	69,565
Asphalt	627,495	615,499
Barium products:		
Manufactured barytes	.....	.....
Lithopone	.....	122,708
Barium carbonate:		
Natural (witherite)	14,134	4,739
Manufactured	.....	2,666
Barium binoxide	.....	.....
Barium chloride	.....	19,846
Blanc-fixe	.....	90
Barytes, crude	.....	594
Borax (including crude, refined, and boracic acid)	26,487	20,896
Burrstones and millstones	20,017	26,356
Cement, hydraulic	1,200	52,636
Chalk:		
Crude	113,985	140,614
Ground or bolted	5,829	6,260
Precipitated	29,263	38,610
Cubes, blocks, sticks, tailor's, etc	4,687	2,995
Manufactures of (not specially provided for)	629	325

Value of mineral products imported for consumption in the United States and of mineral products exported from the United States, 1918 and 1919—Continued.

Nonmetallic products—Continued.

Product.	1918	1919
IMPORTS—continued.		
Clay:		
Kaolin or china clay	$1,153,240	$1,965,393
Other than kaolin	165,554	191,945
Clay products:		
Brick and tile	290,044	193,966
Flattening	576	2,873
Pipes, common tobacco pipes, and pipe bowls of clay	4,716	15,852
Pottery, etc	6,388,864	7,214,209
Coal:		
Anthracite	203,798	522,419
Bituminous	6,694,668	4,950,686
Coke	221,880	140,653
Corundum and emery	614,167	595,203
Cryolite	97,500	106,956
Diatomaceous earth, rotten stone, and tripoli	11,128	12,545
Explosives:		
Fulminates, fulminating powders, etc.:		
Suitable for miners	.....	20
All other	197,940	15,705
Gunpowder and all other substances (not specially provided for)	12,886,196	6,336,518
Mining, blasting, or safety fuses of all kinds	195	1,554
Percussion caps	113,437	.....
Bombs, rockets, Roman candles, and fireworks	.....	1,251
Firecrackers	64,597	280,237
Fertilizers:		
Crude guano, kainite, manure salts, and phosphate	280,544	2,447,583
Potassium chloride	102,109	1,783,916
Potassium sulphate	15,329	188,592
Other potassium salts	809,799	280,980
Sodium nitrate	90,216,935	19,558,963
Flint, flints, and flint stones	127,808	250,096
Fluorspar	169,364	107,631
Fuller's earth	165,535	189,711
Gems, and precious stones (including diamond dust and bort)	22,666,839	91,958,830
Granite	10,981	27,779
Graphite	3,092,475	2,978,096
Grindstones, finished and unfinished	27,361	50,551
Gypsum	126,797	346,070
Keenes cement, or other cement of which gypsum is chief value	2,259	5,984
Hones, oilstones, and whetstones	6,075	12,199
Ichthyol	39,452	38,975
Lead paints, litharge, orange mineral, red lead, white lead	215	8,708
Lime	73,458	128,519
Lithographic stones, not engraved	.....	216,293
Magnesia	508	14,470
Magnesite	927,255	374,032
Marble and stone (exclusive of granite)	257,596	760,190
Mica	1,541,129	1,488,769
Mineral waters	241,641	116,948
Mineral salts, obtained by evaporation from mineral waters	10,231	12,339
Monazite sand and thorium oxide	204,661	48,768
Ocher	193,647	219,817
Peat	.....	16,345
Petroleum and petroleum products:		
Crude	21,319,464	26,442,881
Benzine, gasoline, and naphtha	1,921,895	1,697,341
Ozokerite (mineral wax)	147,805	454,840
Paraffin oil	3,988	60,930
Paraffin wax	546,342	973,521
All other	2,424,448	3,239,475
Pumice stone	33,014	119,781
Pyrite	2,741,676	2,176,565
Salt	281,468	242,704
Sand	91,465	126,586
Sienna and sienna earths	60,154	46,134
Slate	321	691
Strontium salts	2,459	3,380
Sulphur or brimstone	9,542	8,633
Talc	260,576	259,004
Thorium nitrate	.....	5,250
Umber and umber earths	13,859	23,244
Venetian red	3,653	3,509
Zinc oxide	63,746	45,689
Zinc, sulphide of, white	993	4,413
	188,858,341	191,749,151
Increase	.....	2,890,810
Percentage of increase	.....	1.5

Value of mineral products imported for consumption in the United States and of mineral products exported from the United States, 1918 and 1919—Continued.

Nonmetallic products—Continued.

Product.	1918	1919
EXPORTS.		
Abrasives:		
Wheels, emery and other	$3,862,531	$3,032,067
All other	1,982,822	2,809,231
Asbestos:		
Ore and unmanufactured	51,053	157,416
Manufactured	2,493,325	3,531,978
Asphalt:		
Unmanufactured	577,654	1,103,930
Manufactured	577,936	606,918
Cement	5,912,166	7,513,389
Clay:		
Fire	333,880	262,501
All other	192,053	249,571
Coal:		
Anthracite	29,215,689	36,668,131
Bituminous	[a] 78,664,856	[a] 83,708,842
Coke	11,861,408	5,128,119
Earthen, stone, and china ware:		
Building brick	117,263	248,690
Fire brick	5,001,057	2,747,512
Chinaware	318,448	523,861
Earthenware and stoneware	783,577	1,148,051
Sanitary earthenware	377,527	563,734
Tiles, except drain	582,051	628,836
All other	752,651	721,600
Fertilizers (phosphate rock, ground or unground):		
High-grade hard rock	445,419	2,261,852
Land pebble	303,758	904,308
All other	163,308	401,822
Graphite:		
Unmanufactured	121,555	90,185
Manufactured	731,518	788,755
Lime	105,803	108,370
Mica, and manufactures	74,529	109,348
Paints:		
Red lead	662,584	735,177
White lead	1,756,739	3,037,292
Zinc oxide	2,779,507	3,059,276
Petroleum and petroleum products:		
Crude	12,084,250	14,805,546
Gasoline	85,225,574	61,756,864
Naphtha	54,368,166	30,290,030
Illuminating	50,354,414	119,024,479
Fuel oil and gas oil	[b] 66,615,743	[b] 30,818,877
Lubricating:		
Paraffin	1,454,327	1,795,612
All other	74,148,728	83,347,739
Jelly, etc	1,635,590	2,594,338
Paraffin and paraffin wax	22,273,612	24,816,800
Residuum	14,298	1,834,285
Plaster, builders' and common	174,481	164,324
Wall board (substitute for plaster)	421,985	1,141,815
Potash:		
Chlorate	534,491	524,193
All other	837,679	2,231,351
Salt	1,677,577	1,396,625
Sand and gravel	619,414	382,070
Soda:		
Caustic	5,602,813	6,748,762
Sal soda	213,865	178,285
Silicate	404,796	338,818
Soda ash	7,805,550	2,656,608
Other salts of soda	6,587,134	7,226,322
Stone, including marble:		
Unmanufactured	552,261	770,392
Grindstones	210,889	297,068
Roofing slate	65,224	55,164
All other	1,208,164	1,508,997
Sulphur or brimstone	3,626,638	6,325,552
	549,520,330	565,881,678
Increase in 1919		16,361,348
Percentage of increase in 1919		3

[a] Does not include fuel or bunker coal laden on vessels engaged in the foreign trade, which aggregated in value $29,868,023 in 1918 and $48,205,675 in 1919.

[b] Does not include fuel or bunker oil laden on vessels engaged in the foreign trade, which aggregated in value $11,676,053 in 1918 and $29,383,438 in 1919.

Value of mineral products imported for consumption in the United States and of mineral products exported from the United States, 1918 and 1919—Continued.

Summary.

	1918	1919
Imports:		
Metallic	$288,036,200	$195,275,206
Decrease		92,760,994
Percentage of decrease		32
Excess of imports over exports	13,625,217	16,272,604
Excess of imports over exports (percentage)	5	9
Nonmetallic	188,858,341	191,749,151
Increase		2,890,810
Percentage of increase		1.5
Exports:		
Metallic	274,410,983	179,002,602
Decrease		95,408,381
Percentage of decrease		35
Nonmetallic	549,520,330	565,881,678
Increase		16,361,348
Percentage of increase		3
Excess of exports over imports	360,661,989	374,132,527
Excess of exports over imports (percentage)	191	195
Grand total value:		
Imports of metallic and nonmetallic products	476,894,541	387,024,357
Decrease		89,870,184
Percentage of decrease		19
Exports of metallic and nonmetallic products	823,931,313	744,884,280
Decrease		79,047,033
Percentage of decrease		10
Excess of exports over imports	347,036,772	357,859,923
Excess of exports over imports (percentage)	73	92

DETAILED TABLES.

ABRASIVE MATERIALS.

PRODUCTION.

Natural abrasives marketed by producers in the United States, 1914–1919.

Abrasive.	1914		1915		1916	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Millstones	(a)	$43,316	(a)	$53,480	(a)	$44,559
Grindstones and pulpstones	b 48,272	689,344	b 42,623	648,479	b 50,839	766,140
Oilstones and scythestones	(a)	167,948	(a)	115,175	(a)	154,573
Emery and corundum	c 485	c 2,425	c 3,063	c 31,131	c 15,282	c 123,901
Garnet	4,231	145,510	4,301	139,584	6,171	208,850
Abrasive quartz and feldspar	(d)	(d)	(d)	(d)	(d)	(d)
Diatomaceous (infusorial) earth and tripoli e	28,230	252,327	35,304	167,474	45,978	241,553
Pumice	27,591	59,172	27,708	63,185	33,320	82,263
Grinding pebbles					(a)	42,500
Tube-mill lining						
		1,360,042		1,218,508		1,664,339

a Figures not available, as product was not reported by weight.
b Quantity represents grindstones only, as pulpstones were not reported by weight.
c Emery only. No corundum produced.
d See sections on feldspar and silica (quartz).
e Includes rotten stone, but excludes from 1915 to 1918, inclusive, considerable production of diatomaceous earth for special uses upon which the Survey is not at liberty to report.

Natural abrasives marketed by producers in the United States, 1914–1919—Continued.

Abrasive.	1917		1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Millstones	(a)	$43,489	(a)	$92,514	(a)	$66,972
Grindstones and pulpstones	b 54,432	1,147,784	65,339	1,776,282	46,865	1,336,015
Oilstones and scythestones	1,816	168,704	1,010	189,033	1,463	235,943
Emery and corundum	17,135	241,050	10,422	112,878	c 2,601	c 23,203
Garnet	4,995	198,327	4,696	248,161	4,944	310,131
Abrasive quartz and feldspar	(d)	(d)	(d)	(d)	(d)	(d)
Diatomaceous (infusorial) earth and tripoli e	29,102	369,556	22,947	224,801	66,934	713,501
Pumice	35,293	84,814	30,637	91,178	36,051	116,835
Grinding pebbles	12,000	72,191	9,934	82,851	9,448	85,302
Tube-mill lining	3,050	59,250	2,535	46,634		
	.....	2,385,165	.....	2,864,332	.....	2,887,902

a Figures not available, as product was not reported by weight.
b Quantity represents grindstones only, as pulpstones were not reported by weight.
c Emery only. No corundum produced.
d See sections on feldspar and silica (quartz).
e Includes rottenstone, but excludes from 1915 to 1918, inclusive, considerable production of diatomaceous earth for special uses upon which the Survey is not at liberty to report.

IMPORTS.

Value of abrasive materials imported for consumption in the United States, 1914–1919.

Material.	1914	1915	1916	1917	1918	1919
Millstones and burrstones	$15,000	$17,027	$19,816	$18,227	$20,017	$26,356
Grindstones and pulpstones	109,539	68,892	63,277	57,950	27,361	50,551
Hones, oilstones, and whetstones	33,655	14,247	10,614	10,636	6,075	12,199
Emery and corundum	383,436	271,649	240,737	210,602	614,167	595,203
Diatomaceous earth, tripoli, and rottenstone	20,004	27,333	37,573	17,864	11,128	12,545
Pumice	92,668	65,691	116,543	147,278	33,014	119,781
Diamond dust and bort	74,408	75,944	67,290	349,746	475,870	1,420,442
	728,710	540,783	555,850	812,303	1,187,632	2,237,077

EXPORTS.

Value of domestic abrasive materials exported from the United States, 1914–1919.

Material.	1914	1915	1916	1917	1918	1919
Grindstones	$108,040	$128,879	$176,563	$198,772	$210,889	$297,068
Abrasive wheels, emery, and other	572,218	1,200,421	2,240,227	4,481,600	3,862,531	3,032,067
All other	1,123,508	1,403,796	2,035,951	1,941,512	1,982,822	2,809,231

ALUMINUM.

[See under Bauxite and aluminum.]

ANTIMONY AND ANTIMONIAL LEAD.

PRODUCTION.

Mine production of antimony ores in the United States, 1915–1919.[a]

Year.	Quantity (short tons).	Antimony content (short tons).
1915	5,000	2,100
1916	4,500	1,770
1917	1,060	390
1918	190	50
1919	----------	----------

[a] Mine production negligible prior to 1915.

Smelter production of metallic antimony in the United States, 1917–1919.[a]

Year.	From domestic ores.		From foreign ores.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1917	258	$106,812	2,182	$903,348	2,440	$1,010,160
1918	127	32,004	2,490	627,480	2,617	659,484
1919	----------	----------	(b)	(b)	(b)	(b)

[a] Not recorded prior to 1917.
[b] Only two smelters reporting production in 1919 and Survey not at liberty to publish figures.

Secondary antimony and antimony content of secondary alloys recovered from old alloys, scrap, and dross in the United States, 1913–1919.

Year.	Quantity (short tons).	Value.[a]	Year.	Quantity (short tons).	Value.[a]
1913	2,705	$401,963	1917	4,961	$2,061,700
1914	2,646	444,844	1918	5,226	1,317,000
1915	3,102	1,811,568	1919	4,399	717,900
1916	4,480	2,270,016			

[a] Values calculated at average yearly price for ordinary brands of antimony as published by the American Metal Market.

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1913–1919.

Year.	Quantity (short tons).	Value.	Antimony content (short tons).	Year.	Quantity (short tons).	Value.	Antimony content (short tons).
1913	16,665	$1,591,854	2,508	1917	18,646	$3,781,560	2,759
1914	16,667	1,572,167	2,693	1918	18,570	2,826,350	2,566
1915	23,224	3,665,736	3,425	1919	13,874	1,513,968	1,943
1916	24,038	4,483,582	3,496				

IMPORTS.

Antimony imported and entered for consumption in the United States, 1913–1919.

Year.	Antimony ore.[a]			Liquated antimony sulphide.[b]		Metallic antimony.[c]		Antimony oxide and other compounds.[d]	
	Quantity (short tons).	Antimony content (short tons).	Value of antimony content.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	2,860	2,007	$137,361	3	$419	6,240	$798,581	984	$117,169
1914	1,791	1,254	71,341	49	4,004	6,555	736,420	1,372	315,001
1915	2,494	1,544	332,125	.....	.....	7,354	2,660,830	423	132,193
1916	7,840	4,622	1,072,340	.....	.....	7,064	3,548,507	243	109,832
1917	10,083	5,832	1,006,884	796	128,660	11,286	2,829,159	10	5,368
1918	3,363	1,425	177,731	833	113,258	14,011	3,065,619	18	11,904
1919	993	409	54,477	278	19,202	7,159	1,021,587	126	9,501

[a] Classified in tariff classification as "Antimony ores and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

EXPORTS.

Foreign antimony exported from the United States, 1914–1919.[a]

Year.	Ore.			Matte, regulus, or metal.	
	Quantity (short tons).	Antimony content (pounds).	Value.	Quantity (pounds).	Value.
1914	.....	.....	.....	1,600,979	$211,742
1915	.....	195	$8	3,146,135	786,766
1916	231	255,695	9,874	3,018,251	761,045
1917	.....	.....	.....	989,477	169,260
1918	.....	.....	.....	1,410,970	164,666
1919	3	5,380	1,665	429,059	33,913

[a] There are no domestic exports.

PRICES.

The average New York prices for the ordinary grades of metallic antimony for the last 10 years, in cents per pound, are given by the Engineering and Mining Journal as follows:

Average price of metallic antimony at New York, 1910–1919, by years.

1910	7.39	1915	30.28
1911	7.54	1916	25.37
1912	7.76	1917	20.69
1913	7.52	1918	12.58
1914	8.76	1919	8.19

ARSENIC.

PRODUCTION.

White arsenic (As_2O_3) produced in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	1,497	$52,305	1915	[a] 5,498	$302,116
1911	3,132	73,408	1916	[b] 5,986	555,187
1912	3,141	190,757	1917	6,151	1,118,313
1913	2,513	159,236	1918	6,323	1,213,000
1914	[c] 4,670	313,147	1919	6,029	[d] 1,181,684

[a] This quantity includes 353 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.
[b] This quantity includes 152 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.
[c] This quantity includes 200 tons of crude arsenic trioxide carrying about 97.5 per cent As_2O_3.
[d] Only two companies reported production of white arsenic in 1919; both companies have given permission to show quantity but not value. This value has been estimated at 9.8 cents a pound.

IMPORTS.

Arsenic compounds imported and entered for consumption in the United States, 1913–1919.

Year.	Arsenic or arsenious acid (white arsenic, As_2O_3).		Arsenic and sulphide of, or orpiment.		Sheep dip.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1913	1,519	$133,597	3,182	$276,849	.....	$40,036	99,692	$4,431
1914	1,594	109,121	2,034	164,592	.....	34,556	15,476	2,235
1915	1,400	113,677	1,783	154,099	.....	19,916	21,056	4,069
1916	1,071	107,876	1,092	124,818	.....	20,134	23,461	5,028
1917	1,178	264,534	2,777	410,341	.....	15,848	48	189
1918	1,847	441,212	4,842	840,600	.....	23,538	.....	.....
1919	4,389	624,494	2,151	316,687	146,803	12,346	18	14

EXPORTS.

Foreign arsenic and sulphide of, or orpiment, exported from the United States, 1913–1919.[a]

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1913	60,000	$3,135	1917	113,600	$15,840
1914	700	79	1918	80,050	12,017
1915	9,776	526	1919	0	0
1916	1,761	1,256			

[a] There are no domestic exports.

ASBESTOS.

SUPPLY.

Supplies of asbestos in the United States, 1913–1919.

Year.	Production.		Imports (unmanufactured).[a]		Exports. (unmanufactured).		Apparent consumption.[b]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	1,100	$11,000	97,145	$1,928,705	(c)	(c)	(c)	(c)
1914	1,247	18,965	71,866	1,407,758	(c)	(c)	(c)	(c)
1915	1,731	76,952	93,566	1,981,483	(c)	(c)	(c)	(c)
1916	1,479	448,214	116,162	3,303,470	[d] 312	[d] $6,133	(c)	(c)
1917	1,683	506,056	134,108	4,521,172	708	116,580	135,083	$4,910,648
1918	1,002	124,687	137,700	6,337,608	697	51,053	138,005	6,411,242
1919	1,361	251,265	135,270	7,369,685	1,119	157,416	135,512	7,463,534

[a] Mainly from Canada.
[b] Production plus imports minus exports.
[c] Exports not separately recorded prior to July, 1916.
[d] Figures cover period July to December, 1916.

WORLD'S PRODUCTION.

World's production of asbestos, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Percentage of total in 1918.
Canada [a]	124,239	87,580	100,826	121,053	122,925	128,334	88
South Africa:							
Rhodesia [b]	263	442	1,823	5,586	8,675	7,778	5
Union [c]	873	1,080	1,940	4,224	5,642	3,333	2
Russia [d]	17,494	15,691	[e] 9,779	[e] 8,192	.....	[e] 6,000	4
United States	998	1,131	1,570	1,342	1,527	909	1
Italy [f]	175	171	162	82	85	[e] 80	.....
	144,042	106,095	116,100	140,479	138,854	146,434	100

[a] Reports of mineral production of Canada, Canada Dept. Mines, Mines Branch.
[b] Rept. secretary mines, Southern Rhodesia, for the years 1913–1918.
[c] Union of South Africa Ann. Repts. secretary mines and industries and mining engineers for 1918, p. 28.
[d] Mineral industry, 1918.
[e] Estimated; statistics not available.
[f] Rivista del servizio minerario, 1917, p. 63.

ASPHALT AND RELATED BITUMENS.

PRODUCTION.

Asphalt produced in the United States from domestic petroleum, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	161,187	$2,225,833	1915	664,503	$4,715,583
1911	277,192	3,173,859	1916	688,334	6,178,851
1912	354,344	3,755,506	1917	701,809	7,734,691
1913	436,586	4,531,657	1918	604,723	8,796,541
1914	360,683	3,016,969	1919	614,692	8,727,372

Asphalt produced in the United States from Mexican petroleum, 1913–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913	114,437	$1,743,749	1917	645,613	$7,441,813
1914	313,787	4,131,153	1918	597,697	9,417,818
1915	388,318	3,730,436	1919	674,876	7,711,510
1916	572,387	6,018,851			

Native asphalt and related bitumens produced in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	98,893	$854,234	1915	75,751	$526,490
1911	87,074	817,250	1916	98,477	923,281
1912	95,166	865,225	1917	81,604	773,424
1913	92,604	750,713	1918	60,034	780,808
1914	79,888	642,123	1919	88,281	682,989

IMPORTS.

Asphalt and related bitumens imported for consumption in the United States, 1913–1919.

Year.	Crude asphalt.		Dried or advanced asphalt.		Ozokerite.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	[a]207,033	$738,452	[a] 14,750	$133,336	3,571	$549,992
1914	137,352	664,558	.....	.....	4,096	498,695
1915	135,276	661,356	.....	.....	1,398	210,019
1916	147,383	732,917	.....	.....	1,504	196,185
1917	187,473	978,087	.....	.....	450	90,510
1918	114,686	624,967	.....	.....	905	147,805
1919	104,913	609,923	.....	.....	1,874	454,840

Year.	Ichthyol.		Bituminous limestone.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	29	$83,034	6,395	$38,823	231,778	$1,543,637
1914	31	86,415	1,705	11,060	143,184	1,260,728
1915	12	28,560	2,976	19,001	139,662	918,936
1916	58	93,762	330	1,795	149,275	1,024,659
1917	29	36,232	413	15,028	188,365	1,119,857
1918	33	39,452	39	2,528	115,663	814,752
1919	15	38,975	735	5,576	107,537	1,109,314

[a] Last three months of 1913, dried or advanced asphalt included in figures for crude asphalt.

EXPORTS.

Asphalt exported from the United States, 1913–1919.

Year.	Unmanufactured.		Manufactures of (value).	Total value.
	Quantity (short tons).	Value.		
1913	65,576	$1,267,625	$411,786	$1,679,411
1914	41,716	845,838	401,182	1,247,020
1915	42,787	735,952	438,685	1,174,637
1916	40,816	759,769	494,895	1,254,664
1917	30,107	587,256	585,472	1,172,728
1918	22,108	577,654	577,936	1,155,590
1919	40,208	1,103,930	606,918	1,710,848

BARYTES AND BARIUM PRODUCTS.

BARYTES.

SUPPLY.

Supplies of crude barytes in the United States, 1913–1919.

Year.	Domestic barytes produced.		Barytes imported for consumption.		Apparent consumption.[a]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	45,298	$156,275	35,840	$61,409	81,138	$217,684
1914	52,747	155,647	24,423	46,782	77,170	202,429
1915	108,547	381,032	2,504	4,877	111,051	335,909
1916	221,952	1,011,232	17	245	221,969	1,011,477
1917	206,888	1,171,184	6	63	206,894	1,171,247
1918	155,368	1,044,905	.....	.....	155,368	1,044,905
1919	209,330	1,727,822	118	594	209,448	1,728,416

[a] No exports reported. Stocks at plants included, but those at mines excluded.

PRODUCTION.

Crude domestic barytes marketed in the United States, 1918 and 1919, by States.

State.	1918			1919		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Alabama	1,794	$9,976	$5.56	(a)	(a)	(a)
Georgia	69,318	418,178	6.03	85,303	$667,521	$7.83
Kentucky	(a)	(a)	(a)	5,435	36,408	6.70
Missouri	49,094	393,738	8.02	73,247	640,398	8.74
Tennessee	22,542	141,844	6.29	34,700	288,622	8.32
Other States[b]	12,620	81,169	6.43	10,645	94,873	8.91
	155,368	1,044,905	6.73	209,330	1,727,822	8.25

[a] Included under "Other States."
[b] 1918: Kentucky, Nevada, New Mexico, North Carolina, South Carolina, Virginia, and Wisconsin; 1919: Alabama, California, Illinois, Nevada, North Carolina, South Carolina, Virginia, and Wisconsin.

CONSUMPTION.

Crude barytes used in the manufacture of barium products in the United States, 1915–1919, in short tons.

Year.	In manufacture of—		
	Ground barytes.	Lithopone.	Barium chemicals.
1915	53,903	44,503	10,216
1916	75,507	71,898	38,283
1917	60,132	86,065	49,842
1918	62,440	85,282	38,041
1919	64,922	103,688	32,976

BARIUM PRODUCTS.

PRODUCTION.

Barium products of domestic manufacture marketed in the United States, 1915–1919, in short tons.

Product.	1915	1916	1917	1918	1919[a]
Ground barytes	51,557	65,440	52,694	55,086	57,985
Lithopone	46,494	51,291	63,713	62,403	79,643
Barium chemicals [b]	8,823	16,792	22,503	23,186	20,013
	106,874	133,523	138,910	140,675	157,641

[a] Figures for 1919 represent production.
[b] In order to avoid duplication of figures, barium chemicals manufactured from secondary product bought in open market are not included in table.

Barium chemicals of domestic manufacture marketed in the United States, 1915–1919, in short tons.[a]

Chemical.	1915	1916	1917	1918	1919[b]
Barium binoxide	(c)	1,980	(c)	(c)	(c)
Barium carbonate	2,746	6,844	8,238	7,661	7,135
Barium chloride	2,106	3,643	4,870	4,530	4,509
Barium nitrate	971	446	165	(c)	(c)
Barium sulphate (blanc fixe)	(c)	3,337	6,314	9,522	5,227
Other barium chemicals [d]	3,000	542	2,916	1,473	3,142
	8,823	16,792	22,503	23,186	20,013

[a] In order to avoid duplication of figures, barium chemicals manufactured from secondary product bought in open market are not included in table.
[b] Figures for 1919 represent production.
[c] Included under "Other barium chemicals."
[d] 1915: Binoxide, hydroxide, sulphate, sulphide, and other barium chemicals not specified; 1916: Hydroxide and sulphide; 1917: Binoxide, hydroxide, and sulphide; 1918: Binoxide, hydroxide, nitrate, and sulphide; 1919: Binoxide, nitrate, and sulphide.

IMPORTS.

Value of barium products imported and entered for consumption in the United States, 1913–1919.

Product.	1913	1914	1915	1916	1917	1918	1919
Manufactured barytes [a]	$38,155	$30,483	$10,736	$2,072	$1,743	.....	.....
Lithopone [b]	146,474	271,310	137,816	405,730	29,199	.....	$122,708
Barium carbonate:							
Natural (ground witherite)	13,116	8,084	12,165	18,169	17,321	$14,134	4,739
Manufactured (chemically precipitated)	38,949	28,221	2,786	.....	1,554	.....	2,666
Barium binoxide	239,000	332,709	218,776	6,590	.....	.....	.....
Barium chloride	37,620	68,866	31,295	608	.....	.....	19,846
Blanc fixe or artificial barium sulphate	62,785	32,619	18,501	17,810	3,333	.....	90
	576,099	772,292	432,075	450,979	53,150	14,134	150,049

[a] "Manufactured barytes," as given by the Bureau of Foreign and Domestic Commerce, is believed to be the equivalent of "ground barytes" as used by the Geological Survey.
[b] Prior to October, 1913, imported as zinc sulphide white. Figures for 1913 and 1914 have been adjusted on basis of some lithopone having been listed under that name. Since 1914 no lithopone has apparently been imported as zinc sulphide white.

BAUXITE AND ALUMINUM.

BAUXITE.

SUPPLY.

Bauxite supplies in the United States, 1913–1919.

Year.	Domestic production.					
	Georgia, Alabama, and Tennessee.		Arkansas.		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	40,370	$150,710	169,871	$846,988	210,241	$997,698
1914	24,071	92,508	195,247	976,686	219,318	1,069,194
1915	28,245	144,345	268,796	1,370,489	297,041	1,514,834
1916	49,190	284,810	375,910	2,011,590	425,100	2,296,400
1917	62,134	395,051	506,556	2,724,007	568,690	3,119,058
1918	42,829	314,112	562,892	3,133,880	605,721	3,447,992
1919	43,076	346,588	333,490	1,855,159	376,566	2,201,747

Year.	Imports.		Exports.[a]		Domestic consumption.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	21,456	$85,746	(b)	(b)	231,697	$1,083,444
1914	24,844	96,500	c 5,374	c $240,084	238,788	925,610
1915	3,420	17,107	16,082	717,186	284,379	814,755
1916	30	87	17,939	987,454	407,191	1,309,033
1917	7,691	28,989	21,791	1,323,926	554,590	1,824,121
1918	3,653	14,791	19,711	1,523,688	589,663	1,939,095
1919	6,082	36,820	17,701	1,372,094	364,947	866,473

[a] Includes bauxite concentrates.
[b] Not separately classified by Bureau of Foreign and Domestic Commerce prior to July, 1914.
[c] Figures cover six months, July to December. Not separately classified prior to July.

WORLD'S PRODUCTION.

World's production of bauxite, 1913–1918.

Country.	1913		1914		1915	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
United States	210,241	$997,698	219,318	$1,069,194	297,041	$1,514,834
France	304,407	(a)	(a)	(a)	(a)	(a)
United Kingdom	6,055	7,606	8,286	10,507	11,723	15,393
Italy	6,843	16,101	3,844	9,046	6,504	15,942
India	1,184	161	514	156	876	141

Country.	1916		1917		1918	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
United States	425,100	$2,296,400	568,690	$3,119,058	605,721	$3,447,992
France	(a)	(a)	(a)	(a)	(a)	(a)
United Kingdom	10,329	14,477	14,724	20,106	9,589	13,270
British Guiana	(a)	(a)	(a)	(a)	4,199	(a)
Italy	8,746	(a)	7,666	67,647	(a)	(a)
India	750	2,253	1,363	3,017	1,192	4,336
Spain					453	1,598

[a] Figures not available.

ALUMINUM.

PRODUCTION.

Value of aluminum produced in the United States, 1913–1919.

Year.	Primary metal.	Secondary metal.[a]	Year.	Primary metal.	Secondary metal.[a]
1913	$9,450,000	$2,199,480	1917	$45,882,000	$16,711,800
1914	10,080,000	1,673,140	1918	41,159,000	10,113,600
1915	16,280,000	5,802,100	1919	38,558,000	12,014,600
1916	33,900,000	23,430,200			

[a] Value based on average open market price, as quoted by the Engineering and Mining Journal.

IMPORTS.

Aluminum imported for consumption in the United States, 1913–1919.

Year.	Crude and semicrude.[a]		Manufactures of.[b]	Total value.
	Quantity (pounds).	Value.		
1913	25,095,441	$4,388,283	$306,019	$4,784,302
1914	17,942,958	3,353,933	720,650	4,074,583
1915	9,293,574	1,765,967	75,812	1,841,779
1916	6,698,615	1,752,918	32,952	1,785,870
1917	89,291	35,386	21,504	56,890
1918	1,690,683	533,704	20,882	554,586
1919	13,852,065	4,530,579	38,016	4,568,595

[a] Includes crude aluminum, plates, sheets, and wire.
[b] Includes aluminum leaf, kitchen utensils, and all other manufactures of aluminum.

EXPORTS.

Aluminum and manufactures of aluminum exported from the United States, 1913–1919.

Year.	Crude and semicrude.[a]		Manufactures of.	Total value.
	Quantity (pounds).	Value.		
1913			$966,094	$21,611,855
1914			1,546,510	
1915			3,682,117	
1916			15,417,134	
1917 Jan.–June			9,029,458	14,586,467
1917 July–Dec.	10,020,404	$4,571,193	985,816	
1918	24,135,234	8,979,315	1,890,073	10,869,388
1919	5,020,352	1,744,896	2,145,430	3,890,326

[a] Includes ingots, metal and alloys, plates and sheets.

PRICES.

Prices of aluminum in the United States, 1913–1919, in cents per pound.[a]

Year.	Average open market price, small lots.	Contract price.	Year.	Average open market price, small lots.	Contract price.
1913	23.64	(b)	1917	51.59	31–37
1914	18.63	(b)	1918	33.42	(c)
1915	33.98	20–31	1919	32.38	(c)
1916	60.71	31–37			

[a] Engineering and Mining Journal quotations in annual review numbers.
[b] No figures published, but it seems reasonable to believe that contracts were made on approximately the same basis as for 1912, namely, 20 to 21 cents a pound.
[c] Figures not available.

BISMUTH.

PRODUCTION.

There was only one producer of bismuth in this country in 1919. The output was considerably larger in 1919 than in 1918. The bismuth produced in this country is almost entirely a by-product obtained in the refining of lead bullion.

IMPORTS.

Bismuth imported for consumption in the United States, 1913–1919.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1913	117,747	$213,257	1917	69,250	$142,300
1914	90,505	165,208	1918	135,700	277,273
1915	44,362	108,288	1919	57,607	55,179
1916	76,723	195,975			

EXPORTS.

No exports of bismuth are recorded.

BORAX.

[See under Sodium compounds.]

BRIQUETS (FUEL).

PRODUCTION.

Fuel briquets produced in the United States, 1909 and 1911–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	139,661	$452,697	1915	221,537	$1,035,716
1911	218,443	808,721	1916	295,155	1,445,662
1912	220,064	952,261	1917	406,856	2,233,888
1913	181,859	1,007,327	1918	477,235	3,212,793
1914	250,635	1,154,678	1919	295,734	2,301,054

Raw fuels used in making briquets in the United States, 1917–1919, in short tons.

Fuel.	1917	1918	1919	Fuel.	1917	1918	1919
Anthracite culm and fine sizes	137,659	209,690	104,027	Lignite and subbituminous coal	103,408	76,602	80,383
Semianthracite, Semibituminous, Bituminous slack	161,269	180,714	111,955	Oil-gas residue	402,336	467,006	296,365

IMPORTS.

Composition used for fuel in which coal or coal dust is the component material of chief value, whether in briquets or other form, imported for consumption in the United States, 1913–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913		$2,455	1917		
1914		209	1918	(a)	a $280
1915		46		b 432	b 2,797
1916		75	1919	136	1,050

a Figues cover 6 months, January to June. Quantity not shown prior to July.
b Figures cover 6 months, July to December.

BROMINE.

PRODUCTION.

Bromine marketed in the United States, 1913–1919.

Year.	Quantity (pounds).	Value.	Average price per pound.	Year.	Quantity (pounds).	Value.	Average price per pound.
1913	572,400	$115,436	$0.20	1917	895,499	$492,703	$0.55
1914	576,991	203,094	.35	1918	1,727,156	970,099	.56
1915	855,857	856,307	1.00	1919	1,854,971	1,234,969	.67
1916	728,520	951,932	1.31				

IMPORTS.

No imports of bromine are recorded for 1919.

EXPORTS.

Exports are not specifically shown.

CADMIUM.

PRODUCTION.

Metallic cadmium and cadmium sulphide produced in the United States, 1913–1919.

Year.	Metallic cadmium.			Cadmium sulphide.		
	Quantity (pounds).	Value.	Average price per pound.	Quantity (pounds).	Value.	Average price per pound.
1913	54,198	$41,838	$0.77	17,302	$12,136	$0.70
1914	a 91,409	81,205	.89	22,723	20,241	.89
1915	91,415	108,443	1.19	10,624	12,057	1.13
1916	135,212	210,931	1.56	22,176	27,942	1.26
1917	207,408	305,097	1.47	50,169	70,939	1.41
1918	127,164	188,203	1.48	51,702	70,315	1.36
1919	99,939	121,926	1.22	31,197	37,436	1.20

a Exclusive of 4,225 pounds of cadmium in residues sold for export.

IMPORTS.

Cadmium imported and entered for consumption in the United States, 1910–1919.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1910	4,060	$2,295	1915	269	$284
1911	5,367	3,870	1916	.....	.....
1912	5,250	3,764	1917	.....	.....
1913	1,656	1,232	1918	.....	.....
1914	441	368	1919	.....	.....

EXPORTS.

Cadmium licensed for export from the United States, Feb. 1, 1918–Jan. 31, 1919.[a]

Destination.	Quantity (pounds).	Value.	Destination.	Quantity (pounds).	Value.
Canada	3,025	$4,094	Norway	6,740	$8,094
France	30,440	47,960			
Great Britain	2,005	2,612		42,320	63,020
Italy	110	260			

[a] From records of War Trade Board.

Cadmium and its alloys were taken off the conservation list for practically all countries in December, 1918, so that there is little record of licenses for export in 1919 and consequently little information regarding actual exports of cadmium.

CALCIUM CHLORIDE.

PRODUCTION.

Calcium-magnesium chloride marketed in the United States, 1913–1919.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1913	19,611	$130,030	$6.63	1917	30,503	$451,480	$14.80
1914	19,403	121,766	6.28	1918	26,624	503,452	18.91
1915	20,535	130,830	6.37	1919	26,123	321,596	12.31
1916	27,709	224,997	8.12				

IMPORTS AND EXPORTS.

Imports and exports of calcium chloride are not specifically shown.

CEMENT.

SUPPLY.

Supplies of Portland cement in the United States, 1913–1919.

Year.	Domestic shipments.		Imports.		Exports.		Apparent consumption.[a]	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	88,689,377	$89,106,975	85,470	$139,416	2,964,358	$4,270,666	85,810,489	$84,975,725
1914	86,437,956	80,118,475	120,906	194,053	2,140,197	3,088,809	84,418,665	77,223,719
1915	86,891,681	74,756,674	42,218	57,174	2,565,031	3,361,451	84,368,868	71,452,397
1916	94,552,296	104,258,216	1,836	4,942	2,563,976	3,828,231	91,990,156	100,434,927
1917	90,703,474	122,775,088	2,323	6,076	2,586,215	5,328,536	88,119,582	117,452,628
1918	70,915,508	113,316,275	305	1,200	2,252,446	5,912,166	68,663,367	107,405,309
1919	85,612,899	146,734,844	8,931	52,636	2,463,573	7,513,389	83,158,257	139,274,091

[a] Domestic shipments plus imports minus exports.

PRODUCTION.

Principal hydraulic cements produced in the United States, 1913–1919.

Year.	Natural cement.		Portland cement.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	744,658	$345,889	92,097,131	$92,557,617
1914	751,285	351,370	88,230,170	81,789,368
1915	750,863	358,627	85,914,907	73,886,820
1916	[a] 842,137	[a] 430,874	91,521,198	100,947,881
1917	[a] 639,456	[a] 435,370	92,814,202	125,670,430
1918	[a] 432,966	[a] 401,341	71,081,663	113,730,661
1919	[a] 528,589	[a] 583,554	80,777,935	138,130,269

Year.	Puzzolan cement.		Total.	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	107,313	$97,663	92,949,102	$93,001,169
1914	68,311	63,358	89,049,766	82,204,096
1915	42,678	39,801	86,708,448	74,285,248
1916	([a])	([a])	92,363,335	101,378,755
1917	([a])	([a])	93,453,658	126,105,800
1918	([a])	([a])	71,514,629	114,132,002
1919	([a])	([a])	81,306,524	138,713,823

[a] Figures for puzzolan included with natural cement.

Portland cement produced, shipped, and in stock in the United States, 1918 and 1919, by States.

State.	Production.					Stock (barrels).			Shipments.					Average factory price per barrel.	
	Active plants.		Quantity (barrels).		Percentage of change.	1918	1919	Percentage of decrease.	1918		1919			1918	1919
	1918	1919	1918	1919					Quantity (barrels).	Value.	Quantity (barrels).	Value.	Percentage of increase in quantity.		
California	9	8	4,354,074	4,642,679	+ 7	528,026	431,335	18	4,238,424	$7,091,789	4,743,336	$8,860,196	12	$1.67	$1.87
Illinois	4	4	3,594,038	4,206,918	+17	646,255	18,125	97	3,703,471	5,695,186	4,873,831	7,901,689	32	1.54	1.62
Indiana	5	5	5,291,851	7,262,454	+37	822,888	435,985	47	6,205,326	9,580,563	7,667,976	12,527,770	24	1.54	1.63
Iowa	4	4	3,626,455	3,573,278	− 1	1,055,540	126,162	88	3,188,669	5,423,926	4,569,110	7,798,347	43	1.70	1.71
Kansas	7	7	2,499,723	2,927,270	+17	323,008	220,994	32	2,536,834	4,219,203	3,023,901	5,467,284	17	1.63	1.81
Michigan	10	11	3,554,872	4,675,244	+32	635,447	207,965	67	3,618,088	6,078,167	4,990,308	8,468,196	38	1.68	1.70
Missouri	5	5	4,738,596	5,216,347	+10	626,552	160,123	74	4,515,695	7,132,470	5,496,164	9,264,017	22	1.58	1.69
New York	8	8	4,095,588	4,383,579	+ 7	832,271	711,504	15	4,074,159	6,568,746	4,441,250	7,700,406	9	1.61	1.73
Ohio	5	5	1,440,859	1,637,418	+14	262,142	82,614	68	1,289,887	2,208,119	1,821,597	3,311,179	41	1.71	1.82
Oklahoma	3	3	1,246,515	1,362,687	+ 9	89,188	81,225	9	1,218,841	2,203,041	1,366,884	2,657,339	12	1.81	1.94
Oregon and Washington	7	5	1,196,474	1,561,951	+31	287,242	220,906	23	1,327,252	2,535,855	1,615,890	3,359,056	22	1.91	2.08
Pennsylvania	21	21	22,628,901	25,325,173	+12	2,839,018	1,811,551	36	22,238,689	33,600,956	26,250,077	43,126,528	18	1.51	1.64
Texas	5	5	1,971,867	2,249,735	+14	289,779	205,918	29	1,918,919	3,297,977	2,318,747	4,226,222	21	1.72	1.82
Utah	3	3	570,310	819,861	+44	147,293	34,295	77	549,593	1,085,917	935,305	1,906,816	70	1.98	2.04
Other States [a]	18	17	10,271,540	10,933,341	+ 6	1,066,395	476,646	55	10,241,661	16,594,360	11,498,523	20,159,799	12	1.62	1.75
	114	111	71,081,663	80,777,935	+14	10,451,044	5,225,348	50	70,915,508	113,316,275	85,612,899	146,734,844	21	1.60	1.71

[a] 1918: Alabama, Colorado, Georgia, Kentucky, Maryland, Minnesota, Montana, New Jersey, Tennessee, Virginia, West Virginia; 1919: Same States, with Nebraska included.

PRICES.

The average factory price of Portland cement per barrel in bulk in 1919 was $1.71, as compared with $1.60 in 1918. This is the highest price for Portland cement that has been realized since 1894, when the price was $1.73. The lowest average price, $0.813, was recorded in 1909 and 1912.

CHROMITE.

SUPPLY.

Supplies of chromite in United States, 1913–1919.

Year.	Domestic shipments (long tons).	Value.	Imports for consumption (long tons).	Value.	Apparent consumption [a] (long tons).	Value.
1913	255	$2,854	65,180	$622,821	65,435	$625,675
1914	591	8,715	80,736	695,645	81,327	704,360
1915	3,281	36,744	76,455	780,061	79,736	816,805
1916	47,035	726,243	115,945	1,548,402	162,980	2,274,645
1917	43,725	1,049,400	72,063	1,110,659	115,788	2,160,059
1918	82,430	3,955,567	100,142	2,892,825	182,572	6,848,392
1919	5,079	129,302	61,404	1,381,497	66,483	1,510,799

[a] There are no exports of chromite.

WORLD'S PRODUCTION.

On account of the war the records of the world's production of chromite in 1917 and 1918 are incomplete. It is evident, however, that when the records are complete they will show a greater annual production than ever before.

Crude chromite produced by different countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918		
						Production.	Conversion factor.	50 per cent grade.
United States	259	600	3,333	47,788	44,425	84,000	40	67,200
Canada	.....	123	11,196	24,963	33,317	20,000	30	12,000
Cuba	.....	.....	.....	35	17	9,000	40	7,200
Guatemala	.....	.....	.....	.....	182	1,200	58	1,400
Brazil	.....	.....	.....	.....	.....	18,000	45	16,200
Great Britain	.....	100	.....	.....	.....	.....	.....	.....
British South Africa	63,384	49,009	61,590	80,624	43,230	28,000	50	28,000
Turkey (Asia Minor)	14,000	14,000	14,000	14,000	.....	14,000	55	15,400
Greece	6,930	7,059	10,420	9,880	6,750	10,000	48	9,600
Austria-Hungary	305	533	.....	.....	.....	500	50	500
Russia	15,000	15,000	15,000	15,000	.....	16,000	54	17,300
India	5,767	5,986	3,828	20,484	.....	20,000	50	20,000
Australia	685	660	770	460	770	800	55	880
New Caledonia	63,370	71,708	57,474	57,024	41,892	26,000	55	28,600
Japan	1,331	2,108	2,979	8,280	8,939	8,000	40	6,400
	171,000	167,000	181,000	279,000	.....	.....	.....	.....

CLAY.

PRODUCTION.

Domestic clay marketed in the United States, 1913–1919.

Year.	Kaolin.		Paper clay.		Slip clay.		Ball clay.		Fire clay.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	28,834	$235,457	126,377	$567,977	10,902	$24,505	67,134	$237,672	1,820,379	$2,592,591
1914	34,191	284,817	116,328	558,334	8,237	17,731	67,927	255,767	1,409,467	2,147,277
1915	28,031	241,520	113,033	539,622	7,646	18,774	75,348	301,910	1,570,481	2,361,482
1916	47,723	306,819	153,434	768,911	14,064	47,939	89,761	391,152	2,057,814	3,708,009
1917	31,885	301,378	174,449	962,421	16,972	70,505	107,406	569,240	2,347,972	5,625,095
1918	37,969	391,109	141,725	1,068,420	13,552	49,898	89,896	590,631	2,305,033	5,664,064
1919	38,758	490,510	114,070	985,171	5,149	17,556	65,026	520,849	1,755,331	4,628,605

Domestic clay marketed in the United States, 1913–1919—Continued.

Year.	Stoneware clay.		Brick clay.		Miscellaneous clay.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	153,353	$143,587	158,890	$137,976	282,120	$240,694	2,647,989	$4,180,459
1914	130,383	116,610	199,154	161,852	244,173	214,180	2,209,860	3,756,568
1915	134,297	126,429	101,968	93,863	332,150	288,341	2,362,954	3,971,941
1916	135,958	137,779	97,164	76,854	336,672	314,311	2,932,590	5,751,774
1917	81,352	113,839	93,779	94,703	260,029	305,365	3,113,844	8,042,546
1918	86,800	147,098	(a)	(a)	301,386	421,421	2,976,361	8,332,641
1919	60,236	80,367	(a)	(a)	236,530	367,573	2,275,100	7,090,631

a Included under "Miscellaneous clay."

IMPORTS.

Clay imported and entered for consumption in the United States, 1913–1919.

Year.	Kaolin or china clay.			Common blue and Gross-Allmerode glass-pot clay.		All other clays.				Total.	
						Unwrought.		Wrought.			
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	268,666	$1,623,993	$6.04	24,986	$204,911	42,582	$155,693	1,889	$22,178	338,123	$2,006,775
1914	328,038	1,927,425	5.88	16,761	122,325	50,069	195,956	3,232	41,712	398,100	2,287,418
1915	209,132	1,152,778	5.51	8,864	62,569	23,718	90,367	1,343	12,433	243,057	1,318,147
1916	253,707	1,326,684	5.22	2,501	12,134	42,478	163,421	180	1,994	298,866	1,504,233
1917	241,029	1,315,769	5.46	88	709	26,581	123,439	338	2,142	268,036	1,442,059
1918	168,100	1,153,240	6.86	114	983	26,984	163,484	137	1,087	195,335	1,318,794
1919	180,592	1,965,393	10.88	4	133	23,759	187,550	498	4,262	204,853	2,157,338

EXPORTS.

Domestic clay exported from the United States, 1916–1919.[a]

Year.	Fire clay.		All other.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1916	45,752	$144,552	27,941	$145,970	73,693	$290,522
1917	54,023	268,093	29,194	178,764	83,217	446,857
1918	60,206	333,880	24,348	192,053	84,554	525,933
1919	37,486	262,501	30,983	249,571	68,469	512,072

a Figures not available prior to 1916.

CLAY PRODUCTS.

PRODUCTION.

Value of the clay products of the United States in 1918 and 1919.

Product.	1918	1919
Common brick	$38,782,458	$64,162,668
Vitrified brick or block	7,145,359	11,615,144
Face brick	6,095,120	16,033,059
Fancy or ornamental brick	73,086	77,879
Enameled brick	480,772	856,676
Drain tile	8,196,199	11,098,965
Sewer pipe	15,333,673	16,591,810
Architectural terra cotta	2,658,693	4,034,575
Fireproofing and hollow building tile	13,037,102	17,918,180
Tile (not drain)	5,082,069	8,137,452
Stove lining	673,953	683,844
Fire brick	51,647,639	38,015,792
Miscellaneous	7,455,577	8,840,492
Total brick and tile	156,661,700	198,066,536
Total pottery	63,911,793	77,707,762
Grand total	220,573,493	275,774,298

IMPORTS.

Value of clay products imported and entered for consumption in the United States, 1913–1919.

Year.	Pottery.							Total.	Brick, fire brick, tile, etc.	Grand total.
	Brown earthen and common stone ware.[a]	Tobacco pipes and pipe bowls of clay.	Earthenware and crockery composed of a nonvitrified absorbent body.		China and porcelain.		Sanitary earthenware, decorated and not decorated.			
			Not decorated.	Decorated.	Not decorated.	Decorated.				
1913	$238,611	$31,806	[b]$81,978	[b]$523,803	[c]$1,067,209	[c]$8,273,681	.....	$10,217,088	$276,677	$10,493,765
1914	312,934	40,548	438,460	1,968,561	727,725	4,910,365	.....	8,398,593	207,644	8,606,237
1915	227,017	15,155	272,795	1,538,732	458,302	4,116,085	.....	6,628,086	171,801	6,799,887
1916	264,715	10,378	173,192	1,669,712	289,219	3,177,998	$15,371	5,600,585	165,080	5,765,665
1917	518,965	8,209	235,104	1,960,150	157,658	3,409,527	43,701	6,333,314	309,259	6,642,573
1918	436,207	4,716	317,501	2,147,486	200,328	3,269,008	18,334	6,393,580	290,620	6,684,200
1919	293,120	15,852	350,644	2,476,210	359,560	3,726,695	7,980	7,230,061	196,839	7,426,900

[a] Including Rockingham ware and miscellaneous pottery products.
[b] Figures cover period from Oct. 4 to Dec. 31.
[c] Including wares classified under the act of 1913 as china and porcelain wares composed of a vitrified nonabsorbent body: Not decorated, $244,933; decorated, $2,204,851. Only wares composed of a vitrified nonabsorbent body are included after 1913.

EXPORTS.

Value of clay products of domestic manufacture exported from the United States, 1913–1919.

Year.	Building brick.	Firebrick.	Tile (except drain).	Earthen and stone ware.	China.	Sanitary earthenware.	All other.	Total.
1913	$689,515	$1,121,590	$851,463	$410,050	$149,281	.....	$1,566,340	$4,788,239
1914	524,239	734,134	658,695	390,693	136,209	.....	1,134,035	3,578,005
1915	279,336	975,089	276,785	297,127	160,710	[a]$105,615	610,578	2,705,240
1916	189,668	2,406,184	403,184	600,377	262,119	214,076	779,922	4,855,530
1917	196,207	4,011,546	450,422	805,784	422,641	323,558	743,105	6,953,263
1918	117,263	5,001,057	582,051	783,577	318,448	377,527	752,651	7,932,574
1919	248,690	2,747,512	628,836	1,148,051	523,861	563,734	721,600	6,582,284

[a] Figures cover period from July 1 to Dec. 31.

COAL.

PRODUCTION.

Coal produced in the United States, 1913–1919.

Year.	Pennsylvania anthracite.		Bituminous.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	91,524,922	$195,181,127	478,435,297	$565,234,952	569,960,219	$760,416,079
1914	99,821,507	188,181,399	422,703,970	493,309,244	513,525,477	681,490,643
1915	88,995,061	184,653,498	442,624,426	502,037,688	531,619,487	686,691,186
1916	87,578,493	202,009,561	502,519,682	665,116,077	590,098,175	867,125,638
1917	99,611,811	283,650,723	551,790,563	1,249,272,837	651,402,374	1,532,923,560
1918	98,826,084	336,480,347	579,385,820	1,491,809,940	678,211,904	1,828,290,287
1919	88,092,201	364,926,950	465,860,058	1,160,616,013	553,952,259	1,525,542,963

Coal produced in the United States in 1918 and 1919, by States.

State.	1918						
	Loaded at mines for shipment (short tons).	Sold to local trade and used by employees (short tons).	Used at mines for steam and heat (short tons).	Made into coke at mines (short tons).	Total quantity (short tons).	Total value.	Average value per ton.
Alabama	16,061,991	304,038	593,739	2,225,194	19,184,962	$54,752,329	$2.85
Alaska	67,267	6,384	1,955	.....	75,606	411,850	5.45
Arkansas	2,111,992	41,457	73,920	.....	2,227,369	8,172,376	3.67
California and Idaho	5,800	600	.....	.....	6,400	17,250	2.70
Colorado	10,580,811	436,338	311,009	1,079,413	12,407,571	33,404,743	2.69
Georgia	21,725	888	6,250	37,853	66,716	239,377	3.59
Illinois	83,268,864	3,641,044	2,381,197	.....	89,291,105	206,860,291	2.32
Indiana	28,961,651	941,707	775,276	.....	30,678,634	70,384,601	2.29
Iowa	7,399,030	602,556	190,609	.....	8,192,195	24,703,237	3.02
Kansas	7,188,358	173,330	200,259	.....	7,561,947	22,028,142	2.91
Kentucky	29,350,941	1,049,985	678,090	533,601	31,612,617	80,666,842	2.55
Maryland	4,343,293	98,288	55,716	.....	4,497,297	12,466,189	2.77
Michigan	1,280,658	98,954	85,206	.....	1,464,818	5,615,097	3.83
Missouri	5,119,591	385,896	162,243	.....	5,667,730	17,126,498	3.02
Montana	4,177,894	179,079	175,532	.....	4,532,505	11,444,875	2.53
New Mexico	2,836,801	39,075	39,271	1,108,092	4,023,239	10,787,082	2.68
North Carolina	466	42	912	.....	1,420	6,745	4.75
North Dakota	526,046	173,744	19,943	.....	719,733	1,629,668	2.26
Ohio	42,888,610	2,015,720	908,613	.....	45,812,943	118,095,518	2.58
Oklahoma	4,567,930	37,600	207,917	.....	4,813,447	17,508,884	3.64
Oregon	4,112	3,946	5,270	.....	13,328	37,454	2.81
Pennsylvania (bituminous)	137,492,980	4,984,384	3,612,890	32,460,487	178,550,741	463,159,736	2.59
South Dakota	640	7,302	.....	.....	7,942	22,230	2.80
Tennessee	5,904,593	148,130	181,901	596,424	6,831,048	19,305,203	2.83
Texas	2,204 266	11,854	45,015	.....	2,261,135	5,937,997	2.63
Utah	4,238,718	64,827	94,978	738,302	5,136,825	13,937,097	2.71
Virginia	8,188,502	392,712	107,519	1,601,075	10,289,808	25,865,895	2.51
Washington	3,659,830	74,315	193,606	154,461	4,082,212	14,132,869	3.46
West Virginia	81,579,916	2,636,785	1,159,951	4,559,187	89,935,839	230,508,846	2.56
Wyoming	9,055,252	130,777	252,659	.....	9,438,688	22,581,019	2.39
Total bituminous	503,088,528	18,681,757	12,521,446	45,094,089	579,385,820	1,491,809,940	2.58
Pennsylvania anthracite	85,927,696	2,674,439	10,223,949	.....	98,826,084	336,480,347	3.40
Grand total	589,016,224	21,356,196	22,745,395	45,094,089	678,211,904	1,828,290,287	2.70

Coal produced in the United States in 1918 and 1919, by States—Continued.

State.	1918				1919 (production).	
	Number of employees.			Average number of days worked.	Quantity (short tons).	Value.
	Underground.	Surface.	Total.			
Alabama	20,584	5,637	26,221	278	15,536,721	$45,937,681
Alaska	170	69	239	254	60,674	343,547
Arkansas	3,107	871	3,978	204	1,429,020	5,288,844
California and Idaho	10	5	15	240	6,554	22,174
Colorado	11,320	3,163	14,483	255	10,323,420	28,748,534
Georgia	135	55	190	258	53,337	198,033
Illinois	75,270	10,695	85,965	238	60,862,608	140,075,969
Indiana	23,979	6,397	30,376	227	20,912,288	46,345,750
Iowa	11,774	1,554	13,328	245	5,624,692	17,352,620
Kansas	8,652	2,013	10,665	234	5,224,724	15,917,053
Kentucky	30,323	9,019	39,342	230	30,036,061	73,891,049
Maryland	4,377	1,191	5,568	261	3,021,686	8,255,984
Michigan	2,207	351	2,558	237	996,545	3,864,228
Missouri	7,644	1,946	9,590	235	3,979,798	12,766,366
Montana	3,347	1,212	4,559	264	3,236,369	8,644,344
New Mexico	2,971	1,124	4,095	301	3,138,756	9,750,833
North Carolina	35	15	50	40	6,989	26,871
North Dakota	602	226	828	229	840,959	2,100,303
Ohio	39,883	8,567	48,450	223	35,876,682	79,496,301
Oklahoma	7,057	1,394	8,451	228	3,802,113	14,544,901
Oregon	25	15	40	292	18,739	63,794
Pennsylvania (bituminous)	140,502	33,804	174,306	269	150,758,154	365,430,504
South Dakota	21	.....	21	145	14,417	45,707
Tennessee	8,198	2,496	10,694	265	5,213,205	14,448,168
Texas	3,391	545	3,936	262	1,680,656	4,527,640
Utah	3,065	1,095	4,160	258	4,631,323	12,760,613
Virginia	8,788	2,216	11,004	277	9,326,830	23,774,941
Washington	3,836	1,273	5,109	275	2,990,447	10,691,222
West Virginia	69,047	20,483	89,530	238	79,036,553	196,551,015
Wyoming	5,932	1,622	7,554	268	7,219,738	18,751,024
Total bituminous	496,252	119,053	615,305	249	465,860,058	1,160,616,013
Pennsylvania (anthracite)	101,671	45,450	147,121	293	88,092,201	364,926,950
Grand total	597,923	164,503	762,426	258	553,952,259	1,525,542,963

Coal produced in the United States per man employed, 1913–1919.

Year.	Anthracite.				Bituminous.			
	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.	Men employed.	Days worked.	Average tonnage per man per day.	Average tonnage per man per year.
1913	175,745	257	2.02	520	571,882	232	3.61	837
1914	179,679	245	2.06	505	583,506	195	3.71	724
1915	176,552	230	2.19	504	557,456	203	3.91	794
1916	159,869	253	2.16	548	561,102	230	3.90	896
1917	154,174	285	2.27	646	603,143	243	3.77	915
1918	147,121	293	2.29	672	615,305	249	3.78	942
1919	154,571	266	2.14	570	621,998	195	3.83	749

Coal produced in important coal-producing countries of world, 1913–1918, in short tons.

Country.	1913	1914	1915	1916	1917	1918
United States	569,960,219	513,525,477	531,619,487	590,098,175	651,402,374	678,211,904
Great Britain	321,922,130	297,698,617	283,560,980	287,140,410	278,319,149	255,040,328
Germany	305,714,664	270,594,952	259,130,782	272,099,000	[a]281,429,000	[a]273,930,000
Austria-Hungary	60,575,201	[b]53,396,400	[c]52,670,712	[c]55,482,000	[b]50,000,000	[d]
France	45,108,544	32,765,156	[b]21,946,000	[b]23,670,000	[b]31,847,000	[b]30,864,000
Russia	35,500,674	36,414,560	31,158,400	28,962,724	[b]30,047,000	[d]
Belgium	25,196,869	18,424,000	15,691,000	18,588,000	16,446,000	15,229,000
Japan	23,988,292	24,574,000	22,539,000	25,238,000	[b]28,000,000	[b]30,600,000
China	15,432,200	[b]10,199,200	[b]19,800,000	[b]22,000,000	[d]	[d]
India	18,163,856	18,439,975	18,673,984	18,389,372	19,405,550	[d]
Canada	15,115,089	13,637,529	13,267,023	14,461,678	14,046,759	14,979,213
New South Wales	11,663,865	11,644,476	10,582,889	9,102,420	9,290,000	10,160,000
Spain	4,731,647	4,877,000	5,155,000	6,160,380	6,619,102	[d]
Union of South Africa	9,857,361	9,461,674	9,275,083	11,208,402	11,628,870	11,937,682
New Zealand	2,115,834	2,548,664	2,473,659	2,527,991	2,316,629	[d]
Holland	2,064,608	2,121,394	2,488,363	2,920,000	3,326,000	5,277,813
Chile	1,362,334	1,198,000	1,291,000	1,563,000	[d]	[d]
Queensland	1,162,497	1,180,825	1,147,186	1,016,654	1,174,290	1,101,176
Mexico	[b]982,000	[d]	[d]	[d]	[d]	[d]
Turkey	[b]909,000	[d]	[d]	[d]	[d]	[d]
Italy	772,802	859,516	1,045,256	1,439,538	[b]2,090,000	[d]
Victoria	668,524	691,644	588,104	468,270	566,007	[d]
Indo-China	617,912	608,660	708,800	[b]856,000	[d]	[d]
Dutch East Indies	453,136	626,351	485,158	539,816	[b]910,000	[b]1,000,000
Sweden	401,199	404,146	457,184	457,262	[d]	[d]
Western Australia	351,687	357,526	321,065	337,709	[d]	[d]
Serbia	[b]335,000	[d]	[d]	[d]	[d]	[d]
Bulgaria	[b]324,000	[d]	[d]	[d]	[d]	[d]
Peru	301,970	317,923	323,680	351,703	395,802	[d]
Rumania	[b]267,000	[d]	[d]	[d]	[d]	[d]
Rhodesia	237,728	391,394	458,934	491,532	[d]	[d]
Tasmania	61,648	68,130	66,000	62,244	[d]	[d]
Other countries	[b]2,550,000	[d]	[d]	.....	[d]	[d]
Approximate total for the world	1,478,000,000	1,332,000,000	1,312,000,000	1,401,000,000	1,473,000,000	1,468,000,000
Per cent of world total produced by United States	38.5	38.5	40.5	42.1	44.2	46.2

[a] German lignite production estimated at 97,000,000 tons.
[b] Estimate.
[c] Hungarian production estimated at 10,000,000 tons.
[d] Figures not available.

NOTE.—Because of the confusion introduced into the official statistics of many countries, the above figures must be regarded as tentative and subject to revision.

IMPORTS.

Coal imported into the United States, 1913–1919.

Year.	Anthracite.		Bituminous.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	1,031	$5,697	1,611,519	$3,856,811	1,612,550	$3,862,508
1914	21,668	37,998	1,540,353	3,889,821	1,562,021	3,927,819
1915	3,357	14,922	1,703,785	4,398,425	1,707,142	4,413,347
1916	6,376	19,316	1,713,837	4,714,433	1,720,213	4,733,749
1917	12,530	46,523	1,448,453	4,795,110	1,460,983	4,841,633
1918	37,272	204,385	1,457,073	6,694,081	1,494,345	6,898,466
1919	82,818	522,419	1,011,550	4,950,686	1,094,368	5,473,105

EXPORTS.

Coal exported from the United States, 1913–1919.

Year.	Anthracite.		Bituminous.[a]		Total.[a]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	4,652,912	$21,959,850	20,145,168	$45,449,664	24,798,080	$67,409,514
1914	4,289,873	20,211,072	15,458,072	34,104,903	19,747,945	54,315,975
1915	3,965,255	18,429,255	18,776,640	42,817,341	22,741,895	61,246,596
1916	4,665,530	22,470,147	21,254,627	45,828,092	25,920,157	68,298,239
1917	6,007,306	30,909,798	23,839,558	79,502,654	29,846,864	110,412,452
1918	4,967,808	29,215,689	22,350,730	78,664,856	27,318,538	107,880,545
1919	4,976,598	36,668,131	20,113,536	83,708,842	25,090,134	120,376,973

[a] Exclusive of bunker coal.

COBALT.

PRODUCTION.

In 1919 cobalt ores were mined in Idaho and Missouri. In Idaho the Haynes Stellite Co. spent a considerable sum of money in development work but produced no ore. In Missouri the Missouri Cobalt Co. shipped cobalt oxide recovered from ore mined at its property near Fredericktown. In 1918 cobalt ores were mined only in Idaho, where the Haynes Stellite Co. produced 55 tons of concentrates, carrying 17.74 per cent of cobalt (19,514 pounds), from 4,000 tons of ore. Most of the cobalt used in this country has been imported from Canada, where it is obtained as a by-product from silver ores mined in the Cobalt district.

IMPORTS.

Cobalt, and cobalt ore, and zaffer, and cobalt oxide imported and entered for immediate consumption in the United States, 1913–1919.

Year.	Cobalt, and cobalt ore, and zaffer.		Cobalt, oxide of.		Total.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1913	164,119	$69,581	45,277	$26,154	209,396	$95,735
1914	106,670	53,945	227,886	220,593	334,556	274,538
1915	53,375	70,283	154,672	148,828	208,047	219,111
1916	136,770	175,236	206,639	192,009	343,409	367,245
1917	223,794	369,950	276,406	275,821	500,200	645,771
1918	504,391	628,099	208,596	291,699	712,987	919,798
1919	77,556	144,282	131,424	184,751	208,980	329,033

COKE.

PRODUCTION.

Coke produced in the United States, 1913–1919.

Year.	By-product coke.				Beehive coke.				Total.	
	Quantity.		Value.		Quantity.		Value.		Quantity (short tons).	Value.
	Short tons.	Percentage to total.	Amount.	Percentage to total.	Short tons.	Percentage to total.	Amount.	Percentage to total		
1913	12,714,700	27.5	$48,637,852	37.7	33,584,830	72.5	$80,284,421	62.3	46,299,530	$128,922,273
1914	11,219,943	32.5	38,080,167	43.1	23,335,971	67.5	50,254,050	56.9	34,555,914	88,334,217
1915	14,072,895	33.8	48,558,325	46.0	27,508,255	66.2	56,945,543	54.0	41,581,150	105,503,868
1916	19,069,361	35.0	75,373,070	44.1	35,464,224	65.0	95,468,127	55.9	54,533,585	170,841,197
1917	22,439,280	40.4	138,643,153	46.5	33,167,548	59.6	159,599,864	53.5	55,606,828	298,243,017
1918	25,997,580	46.0	193,018,785	50.5	30,480,792	54.0	189,305,583	49.5	56,478,372	382,324,368
1919	25,137,621	56.9	160,244,768	62.0	19,042,936	43.1	98,094,972	38.0	44,180,557	258,339,740

Statistics of the manufacture of coke in the United States, 1913–1919.

Year.	In operation.		Coal used (short tons).	Percentage yield of coke from coal.	Coke produced (short tons).	Total value of coke at ovens.	Value of coke at ovens, per ton.
	Establishments.	Ovens.					
1913	444	72,008	69,239,190	66.9	46,299,530	$128,922,273	$2.78
1914	359	54,638	51,623,750	66.9	34,555,914	88,334,217	2.56
1915	354	54,967	61,832,898	67.2	41,581,150	105,503,868	2.54
1916	389	72,888	81,609,460	66.8	54,533,585	170,841,197	3.13
1917	398	75,985	83,752,371	66.4	55,606,828	298,243,017	5.36
1918	403	70,221	85,028,018	66.4	56,478,372	382,324,368	6.77
1919	373	47,215	65,587,918	67.4	44,180,557	258,339,740	5.85

Beehive and by-product coke produced and sold or used by the producer in the United States, 1918, by States and kinds.

	Production.		Sales.						Used by producer (short tons).
			Furnace.		Foundry.		Domestic and other.		
	Coke (short tons).	Screenings or breeze (short tons).	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Alabama:									
Beehive	1,717,721	100	107,753	$671,587	152,749	$1,475,728	37,710	$278,559	1,412,617
By-product	2,634,451	217,349	109,417	663,586	10,503	58,659	48,333	242,760	2,483,463
	4,352,172	217,449	217,170	1,335,173	163,252	1,534,387	86,043	521,319	3,896,080
Colorado:									
Beehive	758,784	3,629	137,657	1,051,896	37,194	279,448	1,954	77,695	581,044
By-product	230,663	9,701	.....	.....	.....	.....	9,701		230,663
	989,447	13,330	137,657	1,051,896	37,194	279,448	11,655	77,695	811,707
Georgia:									
Beehive	22,048	.....	.....	.....	22,048	193,307	.....	.....	.....
Illinois:									
By-product	2,285,610	187,698	525,538	4,376,183	247,520	2,162,760	298,674	2,194,149	1,236,571
Indiana:									
By-product	3,898,215	290,175	28,377	259,155	187,493	1,862,230	293,952	1,993,325	3,502,061
Kentucky:									
Beehive	301,036	924	276,940	1,648,848	55	292	23,664	146,979	.....
By-product	517,749	16,320	334,467	1,411,586	103,956	714,036	78,598	528,078	.....
	818,785	17,244	611,407	3,060,434	104,011	714,328	102,262	675,057	.....
Maryland:									
By-product	474,368	46,336	4,957	48,434	.....	.....	.....	.....	456,258
Massachusetts:									
By-product	556,397	.....	.....	.....	263,713	(a)	269,754	(a)	.....
Michigan:									
By-product	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Minnesota:									
By-product	784,065	38,054	54,178	371,867	23,714	231,877	249,737	2,240,247	433,747
Missouri:									
By-product	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
New Jersey:									
By-product	682,148	74,725	458,013	(a)	69,794	(a)	162,336	(a)	54,869
New Mexico									
Beehive	597,072	2,120	596,495	3,725,769	.....	.....	76	608	.....
New York:									
By-product	1,069,587	53,362	360,914	3,304,433	8,137	91,063	76,401	736,052	617,743

[a] Included under "Undistributed."

Beehive and by-product coke produced and sold or used by the producer in the United States, 1918, by States and kinds—Continued.

	Production.		Sales.						Used by producer (short tons).
			Furnace.		Foundry.		Domestic and other.		
	Coke (short tons).	Screenings or breeze (short tons).	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Ohio:									
Beehive	138,909				6,850	$340,029			137,299
By-product	5,226,334	505,438	946,763	$6,795,533	36,496		195,150	$950,358	3,952,163
	5,365,243	505,438	946,763	6,795,533	43,346	340,029	195,150	950,358	4,089,462
Oklahoma:									
Beehive	(a)		(a)	(a)					
Pennsylvania:									
Beehive	22,136,664	106,551	18,823,133	109,419,074	1,344,748	9,673,491	78,153	489,599	1,930,364
By-product	4,586,981	327,177	562,034	3,770,419			100,148	505,064	3,935,199
	26,723,645	433,728	19,385,167	113,189,493	1,344,748	9,673,491	178,301	994,663	5,865,563
Tennessee:									
Beehive	302,637	2,268	105,301	749,372	736	6,195			196,835
By-product	124,469		108,335	872,969	13,739	127,827	1,412	11,189	
	427,106	2,268	213,636	1,622,341	14,475	134,022	1,412	11,189	196,835
Utah:									
Beehive	(a)		(a)	(a)	(a)	(a)	(a)	(a)	
Virginia:									
Beehive	1,234,256	4,228	595,967	3,664,201	202,547	1,540,489	4,228	28,619	435,637
Washington:									
Beehive	93,659		75,505	691,532	18,334	220,705	27	202	
By-product	30,129	5,314			3,563	33,849	15,416	146,453	10,132
	123,788	5,314	75,505	691,532	21,897	254,554	15,443	146,655	10,132
West Virginia:									
Beehive	2,716,613	4,322	2,045,779	12,691,751	426,590	3,220,375	54,843	295,204	191,522
By-product	603,393	36,179	72,378	570,426			12,090	91,888	517,763
	3,320,006	40,501	2,118,157	13,262,177	426,590	3,220,375	66,933	387,092	709,285

Wisconsin:									
By-product	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Undistributed:									
Beehive	461,393	.....	452,097	$3,468,278	18,305	$139,672	9,856	$73,595	.....
By-product	2,293,021	$191,542	582,324	8,347,656	662,424	10,279,129	725,357	9,195,509	322,716
	2,754,414	191,542	1,034,421	11,815,934	680,729	10,418,801	735,213	9,269,104	322,716
Total beehive	30,480,792	124,142	23,216,627	137,782,308	2,230,156	16,802,144	210,511	1,319,053	4,885,318
Total by-product	25,997,580	1,999,370	4,147,695	30,792,247	1,631,052	15,849,017	2,537,059	18,907,079	17,753,348
Grand total	56,478,372	2,123,512	27,364,322	168,574,555	3,861,208	32,651,161	2,747,570	20,226,132	22,638,666

a Included under "Undistributed."

Coke produced in beehive and by-product ovens in the United States, 1918, by States.

State.	Beehive coke.					By-product coke.					Total.			
	Active ovens.	Coal used (short tons).	Percentage yield of coke from coal.	Coke produced (short tons).	Value of coke at ovens.	Active ovens.	Coal used (short tons).	Percentage yield of coke from coal.	Coke produced (short tons).	Value of coke at ovens.	Coal used (short tons).	Coke produced (short tons).	Percentage to total production.	Value of coke at ovens.
Alabama	5,570	2,949,992	58.2	1,717,721	$13,973,660	807	3,877,634	67.9	2,634,451	$15,108,576	6,827,626	4,352,172	7.7	$29,082,236
Colorado	1,431	1,216,154	62.4	758,784	(a)	120	345,877	69.5	230,663	(a)	1,562,031	989,447	1.8	7,450,136
Georgia	101	38,280	57.6	22,048	193,317						38,280	22,048		193,317
Illinois						605	3,199,620	71.4	2,285,610	18,625,436	3,199,620	2,285,610	4.0	18,625,436
Indiana						945	5,318,900	73.3	3,898,215	31,462,493	5,318,900	3,898,215	6.9	31,462,493
Kentucky	798	533,346	56.4	301,036	1,798,389	108	723,113	73.9	517,749	2,657,606	1,256,459	818,785	1.4	4,455,995
Maryland						180	696,576	74.8	474,368	(a)	696,576	474,368	.8	(a)
Massachusetts						400	676,866	82.2	556,397	(a)	676,866	556,397	1.0	(a)
Michigan						269	(a)	75.9	(a)	(a)	(a)	(a)	(a)	(a)
Minnesota						214	1,069,775	73.3	784,065	6,806,468	1,069,775	784,065	1.4	6,806,468
Missouri						56	(a)	75.2	(a)	(a)	(a)	(a)	(a)	(a)
New Jersey						260	994,300	68.6	682,148	(a)	994,300	682,148	1.2	(a)
New Mexico	1,053	1,047,675	57.0	597,072	3,729,312						1,047,675	597,072	1.1	3,729,312
New York						615	1,516,580	70.5	1,069,587	9,920,419	1,516,580	1,069,587	1.9	9,920,419
Ohio	198	223,200	62.2	138,909	(a)	1,610	7,775,623	67.2	5,226,334	(a)	7,998,823	5,365,243	9.5	36,691,406
Oklahoma	304	(a)	58.2	(a)	(a)						(a)	(a)	(a)	(a)
Pennsylvania	37,730	34,059,026	65.0	22,136,664	130,739,138	2,189	6,514,868	70.4	4,586,981	29,618,136	40,573,894	26,723,645	47.3	160,357,274
Tennessee	1,101	564,920	53.1	302,637	2,156,591	24	166,157	74.9	124,469	1,020,023	731,077	427,106	.8	3,176,614
Utah	819	(a)	56.3	(a)	(a)						(a)	(a)	(a)	(a)
Virginia	3,135	2,042,429	60.4	1,234,256	8,046,115						2,042,429	1,234,256	2.2	8,046,115
Washington	250	154,460	60.6	93,659	910,459	20	47,410	74.8	30,129	286,226	201,870	123,788	.2	1,196,685
West Virginia	8,827	4,516,108	60.2	2,716,613	17,421,639	214	853,684	70.7	603,393	4,731,205	5,369,792	3,320,006	5.9	22,152,844
Wisconsin						268	(a)		(a)	(a)	(a)	(a)	(a)	(a)
Undistributed		814,707		461,393	10,336,963		3,090,738		2,293,021	72,782,197	3,905,445	2,754,414	4.9	38,977,618
	61,317	48,160,297	63.3	30,480,792	189,305,583	8,904	36,867,721	70.5	25,997,580	193,018,785	85,028,018	56,478,372	100.0	382,324,368

a Included under "Undistributed."

Beehive coke produced in the United States, 1918 and 1919, by groups of States, in short tons.

Group of States.	1918	1919
Pennsylvania and Ohio	22,275,573	14,742,623
West Virginia	2,716,613	1,021,120
Alabama, Tennessee, and Georgia	2,042,406	1,324,153
Virginia and Kentucky	1,535,292	1,214,207
Colorado, Oklahoma, and New Mexico	1,400,856	479,048
Washington and Utah	510,052	261,785
	30,480,792	19,042,936

By-product coke produced in the United States, 1918 and 1919, by States.

State.	1918		1919	
	Ovens (active and idle).	Coke produced (short tons).	Coke produced (short tons).	Value of coke at ovens.
Alabama	847	2,634,451	2,230,933	$11,226,513
Colorado	120	230,663	(a)	(a)
Illinois	626	2,285,610	1,703,903	13,206,405
Indiana	1,026	3,898,215	3,702,180	27,543,179
Kentucky	108	517,749	(a)	(a)
Maryland	180	474,368	356,237	(a)
Massachusetts	400	556,397	393,331	(a)
Michigan	269	(a)	808,729	6,204,747
Minnesota	220	784,065	586,094	3,969,068
Missouri	56	(a)	(a)	(a)
New Jersey	260	682,148	788,465	(a)
New York	615	1,069,587	751,067	5,754,699
Ohio	1,658	5,226,334	5,374,027	30,163,614
Pennsylvania	2,368	4,586,981	5,866,841	33,041,083
Rhode Island	.....	.....	(a)	(a)
Tennessee	24	124,469	(a)	(a)
Washington	20	30,129	(a)	(a)
West Virginia	214	603,393	(a)	(a)
Wisconsin	268	(a)	(a)	(a)
Undistributed	.....	2,293,021	2,575,814	29,135,460
	9,279	25,997,580	25,137,621	160,244,768

a Included under "Undistributed."

IMPORTS AND EXPORTS.

Coke imported into and exported from the United States, 1913–1919.

Year.	Imports for consumption.		Exports.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	101,212	$435,157	987,395	$3,309,930
1914	133,226	551,104	663,585	2,233,686
1915	53,222	222,382	895,509	3,092,498
1916	54,955	249,514	1,174,645	4,202,236
1917	24,872	146,451	1,409,320	8,543,746
1918	30,168	221,880	1,687,824	11,861,408
1919	16,486	140,653	716,956	5,128,119

COKE-OVEN BY-PRODUCTS.

PRODUCTION.

By-products from coke-oven operations in the United States in 1918 and 1919.

1918.

Product.	Production.	Sales.		
		Quantity.	Value.	Average price.
Tar.....gallons..	263,299,470	200,233,002	$6,364,972	$0.032
Ammonia:				
Sulphate.....pounds..	436,388,134	423,515,836	19,061,777	.045
Anhydrous or free ammonia [a].....do....	65,230,159	61,442,933	7,381,174	.120
Gas:				
Illuminating and household purposes..M cu. ft..	385,035,154	33,437,991	7,130,113	.213
Industrial purposes.....do....		124,920,488	6,569,402	.053
Benzol products:				
Crude light oil.....gallons..	87,222,450	3,764,272	963,042	.256
Secondary light oil.....do....	339,644	121,191	15,472	.128
Benzol.....do....	44,804,900	43,441,980	11,966,367	.275
Toluol.....do....	8,861,948	8,541,366	12,249,702	1.434
Solvent naphtha.....do....	3,540,162	3,123,815	439,983	.141
Other oils.....do....	636,707	571,752	53,880	.094
Naphthalene crude.....pounds..	10,614,799	10,403,758	287,581	.028
Naphthalene refined.....do....	5,472,699	5,486,689	362,648	.066
Other products [b].....	.....	.....	1,756,345	.....
	.....	.....	[c] 74,602,458	.....

1919.

Tar.....gallons..	288,901,739	217,707,157	$6,918,549	$0.032
Ammonia:				
Sulphate.....pounds..	544,303,827	557,492,773	21,058,744	.038
Anhydrous or free ammonia [a].....do....	50,535,639	51,646,744	5,692,950	.110
Gas:				
Illuminating and household purposes..M cu. ft..	415,655,098	5,238,486	2,106,806	.402
Industrial purposes.....do....		138,121,007	8,078,442	.058
To public service corporations.....do....		49,464,601	6,464,947	.131
Benzol products:				
Crude light oil.....gallons..	92,473,409	.....	.....	.....
Benzol crude.....do....	44,060,970	44,673,554	7,860,093	.176
Benzol refined.....do....	17,006,532	18,403,909	3,783,552	.206
Toluol crude.....do....	.....	.....	.....	.....
Toluol refined.....do....	1,160,136	1,353,827	355,990	.263
Solvent naphtha.....do....	3,920,489	3,625,978	552,853	.152
Other refined oils.....do....	575,885	127,483	18,358	.144
Naphthalene crude.....pounds..	3,579,998	4,038,455	82,244	.020
Naphthalene refined.....do....	2,763,271	2,663,585	109,120	.041
Other products [d].....	.....	.....	645,142	.....
	.....	.....	[e] 63,727,790	.....

[a] Includes liquor and sulphate sold on pound basis of NH_3.
[b] Sodium ferrocyanide, pyridin oil, nut coke, drip oil, spent oxide, residue, coal-tar paint, and wash oil.
[c] Exclusive of coke breeze.
[d] Sodium ferrocyanide, retort carbon, residue, paint, sodium prussiate, extil covering, crude heavy solvent, and ammonium chloride.
[e] Exclusive of coke breeze, production of which amounted to 1,839,291 short tons, valued at $2,442,541.

COPPER.

SUMMARY OF STATISTICS.

Summary of statistics of the copper industry in the United States, 1913–1919.

	1913	1914	1915	1916
Production of copper:				
Smelter output.....pounds..	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548
Mine production.....do....	1,235,569,727	1,148,431,437	1,488,071,528	2,005,875,312
Refinery production of new copper—				
Electrolytic.....pounds..	1,022,497,601	991,573,073	1,114,345,342	1,579,620,513
Lake.....do....	155,715,286	158,009,748	236,757,062	269,794,531
Casting and pig.....do....	58,611,026	60,840,368	36,603,119	39,337,155
Total domestic.....do....	1,236,823,913	1,210,423,189	1,387,705,523	1,888,752,199
Total domestic and foreign....do....	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315
Total new and old copper.....do....	1,888,000,000	1,790,000,000	2,027,000,000	2,959,000,000
Total ore produced.....short tons..	36,361,101	35,187,118	43,415,133	57,953,357
Copper ore produced.....do....	36,336,682	35,175,541	43,404,182	57,863,365
Average yield of copper.....per cent..	1.67	1.60	1.66	1.70
Average price per pound.....cents..	15.5	13.3	17.5	24.6
Imports (unmanufactured).....pounds..	408,778,954	306,350,827	315,698,449	462,335,980
Exports of metallic copper [a].....do....	926,241,092	840,080,922	681,917,855	784,006,486
Consumption:				
Total new copper.....do....	812,268,639	701,624,158	1,136,618,187	1,478,881,871
Total new and old copper.....do....	1,085,000,000	958,000,000	1,529,000,000	2,179,000,000
World's production.....do....	2,181,253,000	2,054,090,000	2,377,375,000	2,992,046,000
Value of production in the United States....	$189,795,035	$152,968,000	$242,902,000	$474,288,000

	1917	1918	1919
Production of copper:			
Smelter output.....pounds..	1,886,120,721	1,908,533,595	1,286,419,329
Mine production.....do....	1,895,434,349	1,910,022,841	1,212,334,041
Refinery production of new copper—			
Electrolytic.....do....	1,452,744,593	1,560,327,422	1,233,994,324
Lake.....do....	268,508,091	231,096,158	177,594,135
Casting and pig.....do....	152,293,487	91,450,611	21,897,336
Total domestic.....do....	1,873,546,171	1,882,874,191	1,433,485,795
Total domestic and foreign.....do....	2,428,546,171	2,432,385,290	1,805,306,801
Total new and old copper.....do....	3,195,000,000	3,138,000,000	2,380,000,000
Total ore produced.....short tons..	58,514,325	62,304,767	36,139,254
Copper ore produced.....do....	58,482,694	62,289,069	36,121,622
Average yield of copper.....per cent..	1.60	1.51	1.65
Average price per pound.....cents..	27.3	24.7	18.6
Imports (unmanufactured).....pounds..	556,420,297	575,805,115	429,387,594
Exports of metallic copper [a].....do....	1,125,647,336	744,243,481	515,595,019
Consumption:			
Total new copper.....do....	1,394,829,715	1,661,669,576	914,471,572
Total new and old copper.....do....	2,162,000,000	2,367,000,000	1,489,000,000
World's production.....do....	3,137,719,000	(b)	(b)
Value of production in the United States....	$514,911,000	$471,408,000	$239,274,000

[a] Total exports of copper, exclusive of ore, concentrates, and composition metal.
[b] Figures not yet available.

PRODUCTION.

Copper produced in the United States from domestic ores, 1913–1919.

[Smelter output, in pounds fine.]

State.	1913	1914	1915	1916	1917	1918	1919
Alaska	23,423,070	24,985,847	70,695,286	113,823,064	84,759,086	67,081,648	56,534,992
Arizona	404,278,809	382,449,922	432,467,690	694,847,307	719,035,514	769,521,729	536,515,368
California	32,492,265	29,784,173	37,658,444	43,400,876	44,933,846	44,150,761	23,548,698
Colorado	9,052,104	7,316,066	7,272,178	9,536,193	10,054,951	7,591,570	4,892,558
Georgia				803,699	930,691	397,078	8,306
Idaho	8,711,490	5,875,205	6,217,728	7,248,794	6,446,224	5,836,795	3,966,655
Maine					34,872	501,169	376,186
Maryland		12,248	15,426	126,965	291,501		
Michigan	155,715,286	158,009,748	238,956,410	269,794,531	268,508,091	231,096,158	177,594,135
Missouri	576,204	53,519	306,406	377,575	407,141	232,073	588,570
Montana	285,724,467	236,805,845	268,263,040	352,139,768	276,225,977	326,426,761	176,289,873
Nevada	85,209,536	60,122,904	67,757,322	100,816,724	115,028,161	106,266,603	64,683,734
New Jersey				4,115			
New Mexico	50,196,881	64,204,703	62,817,234	79,863,439	107,593,615	96,559,580	60,377,320
North Carolina	180	19,712	33,383	5,961	125,004	79,200	3,334
Oregon	77,812	5,599	797,471	2,433,567	1,105,097	2,630,499	2,808,017
Pennsylvania	245,337	422,741		904	115,000	34,500	

Copper produced in the United States from domestic ores, 1913–1919—Continued.

State.	1913	1914	1915	1916	1917	1918	1919
South Carolina					210,000		2,297
South Dakota							(a)
Tennessee	19,489,654	18,661,112	18,205,308	14,556,278	16,093,757	15,053,568	15,629,454
Texas	39,008	34,272	38,971	86,463	2,061,129	13,851	2,153
Utah	148,057,450	160,589,660	175,177,695	232,335,950	227,840,447	230,964,908	143,836,304
Vermont	5,771		23,995	324,400	102,522	896,630	582,561
Virginia	46,961	17,753	50,008	1,066,143	146,912	1,248	
Washington	732,742	683,602	903,661	2,473,481	2,051,416	2,330,568	2,552,134
Wyoming	362,235	17,082	351,871	1,784,351	2,019,767	866,698	150,051
Undistributed	46,836	65,479					15,476,629
	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595	1,286,419,329

a Included under "Undistributed."

Primary and secondary copper produced by regular refining plants in the United States and imported, 1913–1919, in pounds.

	1913	1914	1915	1916
Primary:				
Domestic a:				
Electrolytic	1,022,497,601	991,573,073	1,114,345,342	1,579,620,513
Lake	155,715,286	158,009,748	b 236,757,062	269,794,531
Casting	22,606,040	21,506,325	21,555,129	12,469,050
Pig and best select	36,004,986	39,334,043	15,047,990	26,868,105
	1,236,823,913	1,210,423,189	1,387,705,523	1,888,752,199
Foreign (electrolytic) a	378,243,869	323,358,205	246,498,925	370,635,116
	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315
Secondary:				
Electrolytic	14,862,577	27,702,928	38,156,789	78,585,296
Casting	22,360,182	4,224,052	21,417,901	25,838,511
	37,222,759	31,926,980	59,574,690	104,423,807
Total output	1,652,290,541	1,565,708,374	1,693,779,138	2,363,811,122

	1917	1918	1919
Primary:			
Domestic a:			
Electrolytic	1,452,744,593	1,560,327,422	1,233,994,324
Lake	268,508,091	231,096,158	177,594,135
Casting	69,916,911	15,284,635	18,223,145
Pig and best select	82,376,576	76,165,976	3,674,191
	1,873,546,171	1,882,874,191	1,433,485,795
Foreign a:			
Electrolytic	c 555,000,000	c 492,181,364	c 370,558,779
Casting and best select		57,329,735	1,262,227
	2,428,546,171	2,432,385,290	1,805,306,801
Secondary:			
Electrolytic	66,337,771	34,674,062	32,408,548
Casting	12,779,125	9,018,049	38,876,481
	79,116,896	43,692,111	71,285,029
Total output	2,507,663,067	2,476,077,401	1,876,591,830

a The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.
b Some Lake copper was refined at seaboard plants and doubtless marketed under some brand other than Lake. This has been excluded from the Lake copper.
c Includes refined copper imported.

In addition to their output of metallic copper the regular refining companies produced in 1919 bluestone having a copper content of 7,883,000 pounds, as compared with 7,917,000 pounds in 1918.

World's production of copper (smelter output), 1910–1919, in pounds.[a]

Country.	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Austria-Hungary	[b] 5,071,000	[b] 5,732,000	[b] 8,818,000	[b] 9,039,000	[c] 7,275,000	.....	.....	.....	.....	[d]
England	1,005,000	877,000	652,000	943,000	763,000	527,000	623,000	419,000	401,000	323,000
Germany	55,334,000	49,383,000	56,438,000	108,907,000	101,853,000	129,852,000	[c] 77,161,000	[c] 99,208,000	[c] 88,184,000	[d]
Italy	3,893,000	3,673,000	5,112,000	4,610,000	4,054,000	2,072,000	4,116,000	2,934,000	2,511,000	3,029,000
Norway	3,999,000	3,450,000	4,696,000	6,043,000	6,305,000	6,235,000	3,558,000	3,990,000	[c] 4,850,000	[c] 970,000
Portugal	[c] 15,432,000	[c] 16,535,000	[c] 14,330,000	[c] 12,787,000	[c] 10,075,000	[c] 9,458,000	[c] 9,502,000	[c] 9,480,000	[c] 8,818,000	[c] 5,071,000
Russia	50,014,000	57,201,000	74,895,000	74,283,000	71,284,000	57,236,000	[c] 29,497,000	[c] 37,478,000	[d]	[d]
Serbia	[b] 10,803,000	[b] 15,432,000	[b] 16,314,000	[b] 14,109,000	.....	.....	.....	.....	.....	.....
Spain	106,993,000	108,490,000	134,520,000	68,889,000	56,671,000	76,497,000	72,487,000	84,934,000	99,436,000	51,630,000
Sweden	6,859,000	7,101,000	8,724,000	9,292,000	10,344,000	10,055,000	7,013,000	9,751,000	6,517,000	7,844,000
Turkey	[b] 1,323,000	[b] 2,205,000	[b] 1,102,000	[b] 1,102,000	.....	.....	.....	.....	.....	.....
Total Europe	260,726,000	270,079,000	325,601,000	310,004,000	268,624,000	291,932,000	203,957,000	248,194,000	[d]	[d]
Canada	55,692,369	55,648,011	77,832,127	76,976,925	75,735,960	100,785,150	117,150,028	109,227,332	118,769,434	75,054,000
Cuba	[b] 7,716,000	[b] 8,377,000	[b] 9,700,000	[b] 7,495,000	[c] 13,890,000	[c] 19,621,000	[c] 20,944,000	[c] 23,589,000	[c] 16,093,000	[c] 18,518,000
Mexico	116,233,000	131,001,000	121,402,000	[c] 116,402,000	[c] 80,116,000	45,410,000	62,634,000	112,404,000	154,813,000	84,150,000
Newfoundland	[b] 2,425,000	[b] 2,646,000	[b] 1,102,000	.....	.....	.....	.....	.....	.....	.....
United States	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595	1,286,419,329
Total North America	1,262,226,000	1,294,905,000	1,453,305,000	1,425,358,000	1,319,879,000	1,553,826,000	2,128,579,000	2,131,341,000	2,198,209,000	1,464,141,000
Argentina	[b] 661,000	[b] 2,205,000	[b] 661,000	[b] 220,000	[c] 661,000	[c] 661,000	[c] 661,000	[c] 661,000	[c] 661,000	.....
Bolivia	[e] 5,600,000	[e] 4,032,000	[e] 4,145,000	1,984,000	4,188,000	11,464,000	14,110,000	16,754,000	[f] 13,450,000	[d]
Chile	84,286,000	80,291,000	91,815,000	93,174,000	98,469,000	115,392,000	157,161,000	226,032,000	[c] 253,529,000	[c] 145,000,000
Peru	60,349,000	61,145,000	59,456,000	61,235,000	59,723,000	76,561,000	94,970,000	99,595,000	97,915,000	86,486,000
Venezuela	.....	[c] 1,609,000	[c] 1,874,000	[c] 1,587,000	[c] 1,587,000	[c] 1,653,000	[c] 1,852,000	[c] 1,896,000	[c] 3,616,000	[d]
Total South America	150,896,000	149,282,000	157,951,000	158,200,000	164,628,000	205,731,000	268,754,000	344,938,000	369,171,000	[d]
Belgian Kongo	.....	[c] 2,227,000	[c] 5,578,000	[c] 16,601,000	[c] 24,007,000	[c] 31,482,000	[c] 49,604,000	[c] 61,509,000	[c] 45,327,000	[c] 51,588,000
Namaqualand	[b] 5,512,000	[b] 5,512,000	[b] 5,512,000	[b] 5,512,000	[c] 5,512,000	.....	.....	.....	.....	.....
Southern Rhodesia	86,000	.....	.....	.....	2,022,000	7,035,000	7,041,000	7,822,000	6,508,000	6,022,000
Union of South Africa	[c] 5,842,000	20,416,000	17,279,000	18,337,000	25,342,000	24,235,000	23,256,000	17,859,000	10,635,000	6,008,000
Total Africa	11,440,000	28,155,000	28,369,000	40,450,000	56,883,000	62,752,000	79,901,000	87,190,000	62,470,000	63,618,000
Japan	108,740,000	117,730,000	137,618,000	146,608,000	155,343,000	166,262,000	221,862,000	238,181,000	199,168,000	172,937,000
Australia	98,224,000	101,365,000	102,168,000	100,633,000	88,733,000	96,872,000	88,993,000	87,875,000	86,674,000	42,564,000
Grand total	1,892,252,000	1,961,516,000	2,205,012,000	2,181,253,000	2,054,090,000	2,377,375,000	2,992,046,000	3,137,719,000	[d]	[d]

[a] Where no footnotes are given, figures are taken from official publications. For countries from which ore or matte was exported for smelting, official figures have been converted to figures showing the quantity of copper recoverable by the smelters.
[b] Compiled by Henry Merton & Co. (Ltd.).
[c] Estimated by the United States Geological Survey.
[d] Figures not yet available.
[e] Figures taken from Chilean official publication.
[f] Incomplete.

STOCKS.

Stocks of refined copper in the United States, January 1, 1917–1920.

	Pounds.
Jan. 1, 1917	128,000,000
Jan. 1, 1918	114,000,000
Jan. 1, 1919	180,000,000
Jan. 1, 1920	631,000,000
Increase in 1919	451,000,000

In addition to the stocks of refined copper on hand January 1, 1920, 310,000,000 pounds of blister copper and material in process of refining was reported as at smelters in the United States, in transit from smelters to refiners, and at refineries, against 562,600,000 pounds on January 1, 1919.

CONSUMPTION.

Apparent consumption of refined new copper in the United States, 1913–1919, in pounds.

	1913	1914	1915	1916
Total supply of new copper	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315
Stocks at beginning of year	105,497,683	90,385,402	173,640,501	82,429,666
Total available supply	1,720,565,465	1,624,166,796	1,807,844,949	2,341,816,981
Copper exported[a]	817,911,424	748,902,137	588,797,096	734,879,881
Stocks at end of year	90,385,402	173,640,501	82,429,666	128,055,229
Total withdrawn from supply	908,296,826	922,542,638	671,226,762	862,935,110
Apparent consumption	812,268,639	701,624,158	1,136,618,187	1,478,881,871

	1917	1918	1919
Total supply of new copper	2,428,546,171	2,432,385,290	1,805,306,801
Stocks at beginning of year	128,055,229	114,000,000	180,000,000
Total available supply	2,556,601,400	2,546,385,290	1,985,306,801
Copper exported[a]	1,047,771,685	704,715,714	439,835,229
Stocks at end of year	114,000,000	180,000,000	631,000,000
Total withdrawn from supply	1,161,771,685	884,715,714	1,070,835,229
Apparent consumption	1,394,829,715	1,661,669,576	914,471,572

[a] Includes unrefined black blister and converter copper (bars, pigs, and other forms) and refined in ingots, bars, rods, or other forms.

IMPORTS.

Copper imported into the United States, 1918 and 1919, in pounds.

1918.

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined in bars plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
United Kingdom	39,220	.....	773,076	112,738	200	300	54,945
Spain	.....	.....	.....	.....	.....	.....	.....
Canada	30,060,903	870,066	787,821	37,881,986	4,951,617	935,112	39,210
Mexico	3,373,084	38,867,789	22,638,810	83,568,187	4,244,197	17,682	.....
Chile	14,707,473	.....	4,239,615	156,285,580	18,264,771	27,506	11,918
Cuba	23,861,119	4,761,704	94,080	.....	.....	550,164	56,347
Peru	1,200,879	.....	2,380,831	81,492,209	8,693,200	6,342	4,259
Japan	.....	.....	.....	827,404	336,022	.....	.....
Other countries	3,629,335	1,768,315	3,162,361	18,203,547	1,597,762	384,433	40,996
	76,872,013	46,267,874	34,076,594	378,371,651	38,087,769	1,921,539	207,675

Copper imported into the United States, 1918 and 1919, in pounds—Continued.

1919.

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined in bars, plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
United Kingdom	.....	.....	201,706	228,083	224,000	.....	223,689
Spain	2,157,072	.....	.....	.....	.....	2,000	.....
Canada	24,487,478	1,608,378	2,105,357	31,199,467	1,860,609	3,612,020	22,412
Mexico	918,091	27,600,065	28,852,151	52,609,210	12,467,393	6,954	.....
Chile	7,636,963	1,456,571	6,407,432	89,859,898	20,449,718	.....	.....
Cuba	11,107,064	3,947,226	925,295	363	.....	362,898	11,061
Peru	1,165,768	.....	304,530	80,829,505	.....	16,799	.....
Japan	.....	.....	.....	600	.....	.....	.....
Other countries	2,244,075	1,800,840	1,529,001	8,493,323	137,040	216,669	98,820
	49,716,511	36,413,080	40,325,472	263,220,449	35,138,760	4,217,340	355,982

EXPORTS.

Copper exported from the United States, 1917–1919, in pounds.

	1917	1918	1919
Ore (copper content)	5,135,818	2,387,275	507,846
Concentrates (copper content)	821,477	872,564	160,821
Unrefined black blister and converter copper (bars, pigs, and other forms)	16,992,357	14,687,823	1,674,411
Refined in ingots, bars, rods, or other forms	1,030,779,328	690,027,891	438,160,818
Composition metal, copper chief value	[a] 1,228,032	186,260	364,089
Old and scrap	1,070,389	257,403	449,804
Pipes and tubes	[a] 7,260,833	4,109,226	5,993,959
Plates and sheets	42,664,931	19,471,584	13,764,425
Wire	26,879,498	15,689,554	55,551,602
	1,132,832,663	747,689,580	516,627,775

[a] Figures cover six months, July to December.

PRICES.

[See statement on page 12A.]

CORUNDUM.

[See under Abrasive materials.]

CRYOLITE.

PRODUCTION.

No natural cryolite is produced in the United States, the entire supply used in this country being imported from Greenland. Recently small quantities of artificial cryolite have been produced by electrochemical processes.

IMPORTS.

Cryolite imported and entered for consumption in the United States, 1910–1919.

Year.	Quantity (long tons).	Value.	Average price per ton.	Year.	Quantity (long tons).	Value.	Average price per ton.
1910	36	$2,343	$65.08	1915	3,940	$82,750	$21.00
1911	2,007	47,093	23.46	1916	3,857	165,222	42.84
1912	2,126	48,293	22.72	1917	4,383	218,500	49.86
1913	2,559	52,557	20.54	1918	1,950	97,500	50.00
1914	4,612	94,424	20.47	1919	2,131	106,956	50.19

DIATOMACEOUS (INFUSORIAL) EARTH.

[See under Abrasive materials.]

EMERY.

[See under Abrasive materials.]

FELDSPAR.

PRODUCTION.

Feldspar sold by producers in the United States, 1909–1919.

Year.	Quantity (short tons).	Value.		Year.	Quantity (short tons).	Value.	
		At price for crude spar.	As sold (crude and ground).			At price for crude spar.	As sold (crude and ground).
1909	76,539	$195,639	$424,602	1915	105,118	$336,667	$489,223
1910	81,102	256,718	502,452	1916	132,681	404,689	702,278
1911	92,700	269,546	579,008	1917	141,924	474,767	728,838
1912	86,572	269,511	520,562	1918	99,120	429,989	674,346
1913	120,955	369,348	776,551	1919	71,054	347,992	585,200
1914	135,419	399,069	629,873				

Feldspar sold by producers in the United States, 1918 and 1919, by States, and the value at price for crude feldspar.

State.	1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
California	1,451	$8,839	(a)	(a)
Connecticut	5,942	29,419	10,880	$84,050
Maine	25,376	105,430	14,387	59,602
Maryland	8,784	40,299	7,820	39,610
New York	12,631	58,076	(a)	(a)
North Carolina	40,020	160,275	25,195	116,826
Pennsylvania	4,916	27,651	(a)	(a)
Undistributed			12,772	47,904
	99,120	429,989	71,054	347,992

[a] Included under "Undistributed."

Feldspar sold in Canada, 1910–1919.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	15,809	$47,667	1915	15,455	$59,124
1911	17,723	51,939	1916	19,488	71,407
1912	13,733	30,916	1917	11,493	54,555
1913	15,935	56,841	1918	18,782	112,728
1914	18,060	70,824	1919	14,679	86,231

[a] Reports on mineral production of Canada, Canada Dept. Mines.

IMPORTS AND EXPORTS.

The United States imports nearly the whole of the Canadian production of feldspar and none from other countries. Imports and exports are not specifically shown by the Bureau of Foreign and Domestic Commerce.

FERROALLOYS.

PRODUCTION.[a]

Ferroalloys of domestic manufacture shipped in the United States, 1911–1919, in long tons.[a]

Year.	Ferromanganese.	Spiegeleisen.	Other varieties.	Total quantity.	Total value.
1911	178,615		74,760	253,375	$8,377,832
1912	227,939		100,746	328,685	12,223,776
1913	119,495	106,980	69,732	296,207	13,015,362
1914	100,731	76,625	78,168	255,524	9,350,245
1915	144,260	114,556	129,828	388,644	17,450,385
1916	224,103	182,837	182,798	589,738	50,281,692
1917	260,225	189,241	184,555	634,021	83,731,724
1918	306,076	263,861	180,931	750,868	115,433,943
1919	198,255	90,855	102,791	391,901	46,290,145

[a] The figures fall short of the actual production of the United States, as the output of certain electrically produced ferroalloys is not available for publication by the Geological Survey.

Ferroalloys of domestic manufacture shipped in the United States, 1916–1918.[a]

Variety of alloy.	1916		1917		1918	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Ferromanganese	224,103	$30,123,493	260,225	$53,930,771	306,076	$69,045,678
Spiegeleisen	182,837	6,158,202	189,241	9,756,236	263,861	17,276,494
Ferrosilicon	166,308	5,273,088	175,079	8,562,182	171,756	11,864,904
Ferrophosphorus	12,966					
Ferrotungsten (50 per cent or more tungsten)	(b)	(b)	1,258	4,225,070	2,142	7,798,898
Other varieties [c]	3,524	8,726,909	8,218	7,257,465	7,033	9,447,969
	589,738	50,281,692	634,021	83,731,724	750,868	115,433,943

[a] The quantity reported falls short of the actual production of the United States, as the output of certain electrically produced ferroalloys is not available for publication by the Geological Survey. Corresponding figures on the ferroalloy industry for 1919 are shown on page 646.

[b] Included under "Other varieties."

[c] 1916: Ferrochrome, ferromolybdenum, ferrotungsten, and ferrovanadium; 1917: Ferrocerium, ferrochrome, ferromolybdenum, ferrocarbontitanium, ferrouranium, and ferrovanadium; 1918: Ferrocerium, ferrochrome, ferrocarbontitanium, ferromolybdenum, ferrotitanium, ferrouranium, ferrovanadium, and ferrozirconium.

IMPORTS.

Ferroalloys imported for consumption in the United States, 1917–1919.

Variety of alloy.	1917		1918		1919	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Chrome or chromium and ferrochrome					414	$100,404
Ferrophosphorus	85	$5,458	10	$1,055	176	13,388
Ferrosilicon	9,740	691,684	5,540	424,932	10,445	629,362
Molybdenum and ferromolybdenum			32	19,280	46	40,759
Titanium and ferrotitanium			(a)	10	5	3,317
Tungsten and ferrotungsten	1	3,606		8	177	287,981
Ferrovanadium					5	24,923
Ferromanganese	41,969	5,710,988	27,168	4,258,745	33,022	4,283,541
Spiegeleisen	3,968	291,594	1,969	228,012	27	1,018
	55,763	6,703,330	34,719	4,932,042	44,317	5,384,693

[a] Ten pounds.

EXPORTS.

Ferromanganese, ferrosilicon, tungsten and ferrotungsten, and ferrovanadium exported from the United States, 1917–1919.

Variety of alloy.	1917		1918		1919	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
Ferromanganese	[a] 2,400	[a] $498,402	3,577	$806,087	2,999	$445,840
Ferrosilicon	[a] 6,849	[a] 719,626	4,107	443,456	1,544	145,310
Tungsten and ferrotungsten	1,038	4,122,653	550	2,545,087	17	113,276
Ferrovanadium	1,084	2,953,260	675	1,774,062	29	95,560

[a] Figures cover six months, July to December.

PRICES.

Prices per ton of ferromanganese and spiegeleisen in the United States, 1916–1919, by months.[a]

Month.	Ferromanganese.[b]				Spiegeleisen.[c]			
	1916	1917	1918	1919	1916	1917	1918	1919
January	$110.00	$175.00	$250.00	[b] $212.50	$32.50	$57.50	$59.00	[c] $67.50
February	140.00	192.50	250.00	165.00	42.50	66.25	59.00	[c] 52.50
March	175.00	212.50	250.00	134.00	55.00	77.50	65.50	[c] 42.50
April	175.00	250.00	250.00	113.75	60.00	76.75	[c] 70.00	[c] 34.50
May	175.00	375.00	[b] 250.00	110.00	60.00	78.00	[c] 71.00	[c] 31.35
June	175.00	400.00	[b] 250.00	111.75	55.00	83.00	[c] 75.00	[c] 27.50
July	175.00	400.00	[b] 250.00	111.00	47.50	85.00	[c] 75.00	34.00
August	170.00	387.50	[b] 250.00	110.00	47.50	81.25	[c] 75.00	34.00
September	164.00	380.00	[b] 250.00	105.00	45.00	80.50	[c] 75.00	34.00
October	160.00	300.00	[b] 250.00	110.00	40.00	73.50	[c] 75.00	34.00
November	155.00	247.50	[b] 250.00	110.00	45.00	63.25	[c] 75.00	34.00
December	162.50	247.50	[b] 236.00	121.00	50.00	60.00	[c] 72.50	39.00

[a] Iron Trade Review.
[b] Prices from May, 1918, to January, 1919, inclusive, based on 70 per cent ferromanganese. All other prices based on 80 per cent metal.
[c] Prices from April, 1918, to June, 1919, inclusive, based on 16 per cent spiegeleisen. All other prices based on 20 per cent metal.

FLUORSPAR.

SUPPLY.

Supplies of fluorspar in the United States, 1913–1919.

Year.	Sales of domestic spar.		Imports for consumption.		Apparent consumption.[a]	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	115,580	$736,286	22,682	$71,463	138,262	$807,749
1914	95,116	570,041	10,205	38,943	105,321	608,984
1915	136,941	764,475	7,167	22,878	144,108	787,353
1916	155,735	922,654	12,323	54,000	168,058	976,654
1917	218,828	2,287,722	13,616	114,598	232,444	2,402,320
1918	263,817	5,465,481	12,572	169,364	276,389	5,634,845
1919	138,290	3,525,574	6,943	107,631	145,233	3,633,205

[a] No exports have been reported.

PRODUCTION.

Fluorspar shipped from mines in the United States, 1918 and 1919, by States.

State.	1918			1919		
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.
Arizona	364	$5,537	$15.21	(a)	(a)	(a)
Colorado	38,475	416,780	10.83	9,687	$150,739	$15.56
New Mexico	3,437	64,348	18.72	2,346	37,643	16.05
Illinois	132,798	2,887,099	21.74	92,729	2,430,361	26.21
Kentucky	87,604	2,069,185	23.62	32,386	883,171	27.27
Other States [b]	1,139	22,532	19.78	1,142	23,660	20.72
	263,817	5,465,481	20.72	138,290	3,525,574	25.49

[a] Included under "Other States."
[b] 1918: New Hampshire, Utah, and Washington; 1919: Arizona, Nevada, New Hampshire, and Utah.

Fluorspar produced in some principal countries, 1913–1918, in metric tons.[a]

Country.	1913	1914	1915	1916	1917	1918
United States	104,853	86,289	124,230	141,282	198,519	239,333
Canada				1,165	3,855	6,679
Great Britain	54,522	34,357	33,653	55,607	65,912	54,357
Spain	351	79	370	277	250	350
France	7,524	(b)	(b)	(b)	(b)	(b)
Australia:						
New South Wales			424	1,407	1,631	2,315
Queensland					72	

[a] No statistics are available for Germany and Austria-Hungary, but the annual pre-war output of these countries was about 8,000 tons and 20,000 tons, respectively.
[b] Figures not yet available.

FULLER'S EARTH.

PRODUCTION.

Domestic fuller's earth marketed in the United States, 1910–1919.

Year.	Number of operators.	Quantity (short tons).	Value.	Average price per ton.	Year.	Number of operators.	Quantity (short tons).	Value.	Average price per ton.
1910	17	32,822	$293,709	$8.95	1915	12	47,901	$489,219	$10.21
1911	13	40,697	383,124	9.41	1916	10	67,822	706,951	10.42
1912	13	32,715	305,522	9.34	1917	11	72,567	772,087	10.64
1913	10	38,594	369,750	9.58	1918	14	84,468	1,146,354	13.57
1914	14	40,981	403,646	9.85	1919	10	106,145	1,998,829	18.83

IMPORTS.

Fuller's earth imported and entered for consumption in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1910	16,587	$132,545	$7.99	1915	19,441	$152,493	$7.84
1911	18,224	143,594	7.88	1916	16,801	139,664	8.31
1912	19,109	145,337	7.61	1917	16,994	176,417	10.38
1913	18,628	146,001	7.84	1918	12,607	165,535	13.13
1914	24,977	195,083	7.81	1919	13,873	189,711	13.67

EXPORTS.

Exports of fuller's earth are not reported separately.

GARNET (ABRASIVE).

[See under Abrasive materials.]

GAS (ARTIFICIAL) AND BY-PRODUCTS.

Artificial gas produced and sold in the United States in 1917 and 1918, by States.

[Including coke-oven gas.]

1917.

State.	Number of plants producing.	Production (M cubic feet).	Sales.			Unaccounted for (M cubic feet).
			Quantity (M cubic feet).	Value.	Average price per M.	
Alabama	21	45,575,801	14,467,616	$1,658,001	$0.11	4,741,983
Arizona	9	289,186	258,412	413,700	1.60	30,774
Arkansas and Oklahoma	4	52,200	45,384	51,594	1.14	6,816
California	55	15,382,623	12,911,672	11,344,485	.88	2,470,951
Colorado	12	1,985,189	1,785,047	1,396,575	.78	200,142
Connecticut	29	6,021,869	5,504,141	5,454,677	.99	517,728
Delaware	6	745,085	669,641	632,318	.94	75,444
District of Columbia and Maryland	17	12,238,455	10,702,584	5,158,037	.48	644,553
Florida	16	981,411	882,067	1,131,523	1.28	99,344
Georgia	18	1,834,907	1,677,632	1,747,027	1.04	157,275
Idaho	3	92,929	83,826	126,257	1.51	9,103
Illinois	88	64,655,011	40,961,382	22,940,197	.56	4,154,380
Indiana	53	54,250,109	28,022,093	5,510,651	.20	1,537,024
Iowa	63	4,049,873	3,710,418	3,750,412	1.01	339,455
Kansas	7	115,562	104,537	131,239	1.26	11,025
Kentucky	10	8,400,618	4,294,599	334,159	.08	31,507
Louisiana	3	1,617,838	1,488,517	1,505,448	1.01	129,321
Maine	12	694,882	635,838	738,361	1.16	59,044
Massachusetts	70	24,448,210	19,034,012	14,420,276	.76	922,539
Michigan	77	24,559,349	13,102,278	7,293,561	.56	3,517,799
Minnesota	22	12,861,044	8,164,655	4,337,679	.53	870,893
Mississippi	9	231,105	171,432	218,745	1.28	59,673
Missouri	25	11,391,428	9,024,701	6,772,260	.75	504,491
Montana	6	249,493	211,453	339,352	1.60	38,040
Nebraska	17	1,630,078	1,528,518	1,634,296	1.07	101,560
Nevada	4	72,007	59,553	105,029	1.76	12,454
New Hampshire	12	760,824	697,045	804,173	1.15	63,779
New Jersey	34	24,109,147	17,145,974	13,445,832	.78	2,874,647
New Mexico and Wyoming	4	66,435	54,197	75,707	1.40	12,238
New York	98	79,855,470	58,970,761	44,477,695	.75	7,994,600
North Carolina	22	712,272	614,568	752,646	1.22	97,704
North Dakota	6	213,989	185,866	239,704	1.29	28,123
Ohio	24	55,452,672	24,888,287	1,984,766	.08	5,196,586
Oregon	10	1,854,186	1,549,607	1,604,637	1.04	304,579
Pennsylvania	95	82,381,832	37,248,111	17,722,630	.48	6,391,220
Rhode Island	7	2,938,647	2,772,908	2,490,285	.90	165,739
South Carolina	9	510,401	446,270	511,774	1.15	64,131
South Dakota	10	303,126	272,761	370,638	1.36	30,365
Tennessee	12	2,170,113	1,349,702	1,329,405	.99	501,411
Texas	22	2,167,572	1,914,387	2,140,530	1.12	253,185
Utah	4	557,419	491,156	438,882	.89	66,263
Vermont	10	272,727	242,298	314,182	1.30	30,429
Virginia	22	2,347,344	2,114,750	2,033,379	.96	232,594
Washington	17	2,106,584	1,936,425	1,645,002	.85	170,159
West Virginia	6	7,367,927	2,967,261	264,532	.09	10,212
Wisconsin	42	16,588,841	6,786,787	3,239,166	.48	692,777
	1,122	577,163,790	342,151,129	195,031,424	.57	46,424,059

Artificial gas produced and sold in the United States in 1917 and 1918, by States—Contd.

[Including coke-oven gas.]

1918.

State.	Number of plants producing.	Production (M cubic feet).	Sales.			Unaccounted for (M cubic feet).
			Quantity (M cubic feet).	Value.	Average price per M.	
Alabama	21	45,687,951	16,444,475	$1,796,335	$0.11	1,896,889
Arizona	8	478,366	295,038	480,684	1.63	183,328
Arkansas, Louisiana, and Oklahoma	6	122,824	104,698	141,751	1.35	18,126
California	54	16,779,097	14,105,255	13,242,140	.94	2,673,842
Colorado	14	5,722,217	3,525,678	1,632,508	.46	586,138
Connecticut	28	6,808,327	6,195,291	6,659,453	1.07	613,036
Delaware	6	860,452	754,370	804,137	1.07	106,082
District of Columbia and Maryland	16	19,291,102	11,764,858	7,534,289	.64	578,101
Florida	16	1,115,097	977,666	1,340,210	1.37	137,431
Georgia	18	2,170,943	1,951,304	2,050,297	1.05	219,639
Idaho	3	92,657	78,433	129,124	1.65	14,224
Illinois	84	66,553,065	41,611,240	23,729,695	.57	3,092,855
Indiana	53	58,912,920	30,780,904	5,885,540	.19	3,196,358
Iowa	68	4,250,715	3,909,402	4,243,626	1.09	341,313
Kansas	8	140,542	123,980	164,957	1.33	16,562
Kentucky	10	8,211,016	4,279,853	202,914	.05	37,564
Maine	12	791,949	702,593	902,647	1.28	89,356
Massachusetts	70	25,385,944	20,377,687	17,875,542	.88	1,624,257
Michigan	78	25,526,416	15,854,146	9,338,332	.59	1,269,099
Minnesota	25	14,020,752	8,578,614	3,557,029	.41	224,384
Mississippi	9	270,414	210,249	265,326	1.26	60,165
Missouri	25	11,844,529	8,732,546	6,782,666	.78	1,186,021
Montana	7	253,482	215,090	346,435	1.65	38,392
Nebraska	18	1,716,718	1,573,251	1,931,888	1.23	143,467
Nevada	4	66,669	55,383	100,887	1.82	11,286
New Hampshire	13	813,626	735,556	951,616	1.29	78,070
New Jersey	36	24,157,945	18,692,369	13,995,166	.75	1,855,225
New Mexico and Wyoming	4	70,021	60,112	88,116	1.47	9,909
New York	97	92,898,494	73,143,190	57,235,865	.78	6,395,186
North Carolina	22	795,197	672,065	949,267	1.41	123,132
North Dakota	6	236,098	174,354	314,578	1.80	61,744
Ohio	29	78,364,690	37,071,480	2,597,138	.07	5,612,435
Oregon	10	2,512,260	2,200,382	1,901,879	.86	311,878
Pennsylvania	94	87,485,018	40,005,978	20,675,457	.52	7,352,301
Rhode Island	7	3,102,283	2,972,695	3,134,701	1.05	129,588
South Carolina	10	662,282	584,075	754,469	1.29	78,207
South Dakota	10	306,990	271,884	420,614	1.55	35,106
Tennessee	10	2,190,841	1,578,819	1,169,727	.74	232,701
Texas	24	2,645,694	2,262,819	2,529,242	1.12	382,875
Utah	4	552,550	500,403	493,680	.99	52,147
Vermont	10	295,525	263,656	358,517	1.36	31,869
Virginia	22	2,583,339	2,329,338	2,271,133	.98	254,001
Washington	16	2,596,459	2,312,713	2,370,192	1.02	283,746
West Virginia	6	9,029,198	4,387,080	371,344	.09	5,627
Wisconsin	43	18,067,803	9,878,574	4,006,525	.40	620,957
	1,134	646,440,477	393,299,546	227,730,638	.58	42,264,619

Artificial gas produced and sold in the United States in 1915, 1917, and 1918, by kinds.

Kind.	Year.	Production (M cubic feet).	Sales.		Unaccounted for (M cubic feet).
			Quantity (M cubic feet).	Value.	
Coal	1915	47,638,905	43,747,432	$40,257,108	3,891,473
	1917	47,525,148	42,927,728	38,324,113	4,597,420
	1918	48,486,546	42,659,487	42,846,964	5,827,059
Water	1915	136,333,318	124,129,569	112,281,956	12,203,749
	1917	174,357,536	153,457,318	131,876,065	20,900,218
	1918	193,046,980	175,597,423	155,426,672	17,449,557
Oil	1915	16,035,105	13,971,333	12,668,169	2,063,772
	1917	17,552,855	14,739,508	13,470,911	2,813,347
	1918	19,871,797	16,684,157	15,757,487	3,187,640
Coke-oven	1915	213,667,614	84,355,914	8,624,899	6,139,827
	1917	337,728,251	131,026,575	11,360,335	18,113,074
	1918	385,035,154	158,358,479	13,699,515	15,800,363
Total	1915	413,674,942	266,204,248	173,832,132	24,298,821
	1917	577,163,790	342,151,129	195,031,424	46,424,059
	1918	646,440,477	393,299,546	227,730,638	42,264,619

Gas and by-products from artificial-gas plants in the United States in 1918.

Product.	Production.	Sales.	
		Quantity.	Value.
Gas:	*M cubic feet.*	*M cubic feet.*	
Coal gas	48,486,546	42,659,487	$42,846,964
Water gas	193,046,980	175,597,423	155,426,672
Oil gas	19,871,797	16,684,157	15,757,487
Coke-oven gas	385,035,154	158,358,479	13,699,515
	646,440,477	393,299,546	227,730,638
Coke:	*Short tons.*	*Short tons.*	
Coal gas	3,180,535	1,813,740	13,963,232
Coke-oven	25,997,580	(a)	(a)
	29,178,115	.....	.....
Tar:	*Gallons.*	*Gallons.*	
Coal gas	52,694,826	47,727,839	1,863,580
Water gas	100,268,434	54,733,478	1,789,898
Oil gas	716,722	550,006	15,967
Coke-oven gas	263,299,470	200,233,002	6,364,972
	416,979,452	303,244,325	10,034,417
Ammonia (sulphate equivalent):	*Pounds.*	*Pounds.*	
Coal gas	59,348,144	56,900,464	1,453,070
Coke-oven gas	697,308,770	669,287,568	26,442,951
	756,656,914	726,188,032	27,896,021
Crude light oil and derived products:	*Gallons.*	*Gallons.*	
Coal gas	5,729,629	2,032,883	1,457,972
Water gas	11,909,702	4,613,751	3,830,392
Coal and water gas	4,230,908	2,229,535	1,220,138
Oil gas	21,494	20,376	4,274
Coke-oven gas	87,222,450	59,564,376	25,688,446
	109,114,183	68,460,921	32,201,222
Drip or holder oils:	*Gallons.*	*Gallons.*	
Coal gas	179,614	176,289	42,949
Water gas	3,484,165	3,430,232	455,949
	3,663,779	3,606,521	498,898
Naphthalene (crude and refined):	*Pounds.*	*Pounds.*	
Coal gas	429,798	392,997	10,675
Water gas	539,884	503,083	3,607
Coke-oven gas	16,087,498	15,890,447	650,229
	17,057,180	16,786,527	664,511
Retort carbon:	*Pounds.*	*Pounds.*	
Coal gas	2,202,853	2,014,961	13,275
Water gas	521,748	501,723	2,230
Coke-oven gas	1,310,020	1,310,020	2,732
	4,034,621	3,826,704	18,237
	Pounds.	*Pounds.*	
Lampblack: Oil gas	262,022,000	[b] 35,355,000	95,211
Miscellaneous by-products:			
Coal and water gas	.....	.....	25,826
Coke-oven	.....	.....	1,753,613
	.....	.....	1,779,439
Total value of sales of gas and by-products:			
Coal-gas, water-gas, and oil-gas plants	.....	.....	240,279,368
By-product coke ovens, excluding coke	.....	.....	74,602,458
			314,881,826

[a] Sales of coke from by-product ovens not comparable, as 90 per cent of the production is used by the operator. The total value of the coke produced including estimates for coke consumed in associated iron furnaces, but not sold, was $193,018,785.

[b] In addition, lampblack used for briquets, 80,124,000 pounds.

GAS (NATURAL).

PRODUCTION AND CONSUMPTION.

Natural gas produced and consumed in the United States, 1917 and 1918.

State.	Production.			Consumption.		
	Volume (M cubic feet).	Value.	Average price (cents per M cubic feet).	Volume (M cubic feet).	Value.	Average price (cents per M cubic feet).
1917.						
West Virginia	308,617,101	$57,389,161	18.60	[a] 115,488,192	$10,558,612	9.14
Oklahoma	137,384,154	13,984,656	10.18	[b] 122,177,676	10,900,827	8.92
Pennsylvania	133,397,206	28,716,492	21.53	202,259,498	40,773,689	20.16
Ohio	68,917,231	18,434,814	26.75	165,782,369	44,742,782	26.99
California	49,427,331	6,816,524	13.79	49,427,331	6,816,524	13.79
Louisiana	31,286,476	3,262,987	10.43	[c] 31,286,476	3,262,987	10.43
Kansas	24,438,848	5,701,436	23.33	[d] 37,962,857	8,463,767	22.29
Texas	17,047,292	3,192,625	18.73	17,901,637	3,433,123	19.18
New York	8,371,747	2,499,303	29.85	22,466,848	6,912,540	30.77
Arkansas	5,609,484	315,612	5.63	[e] 6,437,608	396,612	6.16
Illinois	4,439,016	479,072	10.79	[f] 4,439,016	479,072	10.79
Kentucky	2,802,079	580,380	20.71	12,053,445	3,114,402	25.84
Indiana	1,711,454	453,310	26.49	5,766,466	1,971,435	34.19
Wyoming, Colorado	1,223,136	144,425	11.81	1,223,136	144,425	11.81
Montana	334,421	81,406	24.34	334,421	81,406	24.34
South Dakota, Alabama, North Dakota	59,666	25,213	42.26	59,666	25,213	42.26
Missouri	31,425	8,230	26.19	31,425	8,230	26.19
Tennessee	10,900	2,450	22.48	10,900	2,450	22.48
Michigan	1,184	1,013	85.55	1,184	1,013	85.55
Iowa	225	225	100.00	225	225	100.00
	795,110,376	142,089,334	17.87	795,110,376	142,089,334	17.87
1918.						
West Virginia	265,160,917	41,324,365	15.58	108,673,444	12,284,789	11.30
Oklahoma	124,317,179	15,805,135	12.71	106,661,404	12,724,364	11.92
Pennsylvania	123,813,358	38,608,883	31.18	177,139,804	44,777,220	25.27
Ohio	61,261,069	24,234,741	39.55	143,585,260	43,694,161	30.43
California	39,718,941	7,951,666	20.01	39,718,941	7,951,666	20.01
Louisiana	36,094,132	4,912,235	13.60	26,324,150	2,597,035	9.86
Kansas	27,824,641	6,640,781	23.86	33,912,283	7,064,218	20.83
Texas	13,439,624	5,027,449	37.40	20,282,713	5,518,462	27.20
New York	8,460,583	5,673,131	67.05	20,341,207	6,779,207	33.32
Arkansas	5,294,663	575,115	10.86	12,229,288	1,971,100	16.11
Illinois	4,473,018	620,949	13.88	4,473,018	620,949	13.88
Wyoming	4,338,840	156,171	3.59	4,338,840	156,171	3.59
Kentucky	3,022,439	665,843	22.03	12,200,190	3,093,393	25.35
Tennessee	1,826,725	361,140	19.76	1,826,725	361,140	19.76
Indiana	1,666,822	899,671	53.97	4,516,583	1,510,404	33.44
Montana	177,039	62,148	35.10	177,039	62,148	35.10
South Dakota	42,186	19,109	45.29	42,186	19,109	45.29
Maryland, Utah, Washington	25,916	2,700	10.41	25,916	2,700	10.41
Missouri	22,120	5,548	25.08	4,511,221	2,358,544	52.28
Colorado	10,103	2,575	25.48	10,103	2,575	25.48
Alabama	4,600	1,890	41.08	4,600	1,890	41.08
Oregon	2,200	550	25.00	2,200	550	25.00
Iowa	1,758	245	13.93	1,758	245	13.93
Michigan	1,173	1,045	89.08	1,173	1,045	89.08
North Dakota	913	475	52.02	913	475	52.02
	721,000,959	153,553,560	21.29	721,000,959	153,553,560	21.29

[a] Includes gas piped from West Virginia and consumed in Maryland.
[b] Includes gas piped from Oklahoma and consumed in Missouri.
[c] Includes gas piped from Louisiana and consumed in Arkansas and Texas.
[d] Includes gas piped from Kansas and consumed in Missouri.
[e] Includes gas piped from Oklahoma.
[f] Includes gas piped from Illinois and consumed in Indiana.

1919: The production of natural gas in 1919 was 739,915,781,000 cubic feet, valued at $132,888,300. Figures by States are shown in tables on pages 126A to 153A.

GASOLINE FROM NATURAL GAS.

PRODUCTION.

Natural-gas gasoline produced in the United States, 1917 and 1918.

1917.

State.	Number of operators.	Plants.		Gasoline produced.			Estimated volume of gas treated (M cubic ft.).	Average yield of gasoline per thousand cubic feet of gas (gallons).
		Number.	Daily capacity (gallons).	Quantity (gallons).	Value.	Price per gallon (cents).		
Oklahoma	167	234	492,436	115,123,424	$21,541,905	18.71	84,719,941	1.359
West Virginia	128	188	135,663	32,668,647	6,511,813	19.93	167,771,351	.195
California	45	49	99,761	28,817,604	4,438,022	15.40	45,351,247	.635
Pennsylvania	287	251	59,164	13,826,250	2,778,098	20.01	49,487,056	.279
Texas	10	11	32,550	6,920,405	1,149,441	16.61	12,677,216	.546
Ohio	49	61	25,137	5,439,560	1,051,376	19.33	30,062,141	.181
Louisiana	15	20	20,118	4,979,754	814,747	16.36	2,233,511	2.229
Illinois	33	55	17,392	4,934,009	866,033	17.55	2,685,895	1.837
Kentucky	5	5	13,400	3,818,209	763,186	19.99	24,915,946	.153
Kansas	4	6	4,642	1,174,980	241,219	20.53	9,315,339	.126
New York, Colorado	7	6	2,122	181,262	33,116	18.27	68,154	2.659
	750	886	902,385	217,884,104	40,188,956	18.45	429,287,797	.508

1918.

State.	Number of operators.[a]	Number of plants.	Gasoline produced.			Gas used.	
			Quantity (gallons).	Value.	Average price per gallon (cents).	Estimated volume (M cubic ft.).	Average yield of gasoline per thousand cubic feet (gallons).
Oklahoma	133	276	163,700,550	$28,389,045	17.3	78,322,307	2.09
West Virginia	79	208	37,603,903	7,498,804	19.9	163,929,550	.23
California	29	56	32,368,933	5,009,152	15.5	50,490,019	.64
Pennsylvania	200	282	15,775,058	3,249,233	20.6	56,982,063	.28
Texas	8	13	7,326,122	1,214,565	16.6	8,493,182	.86
Louisiana	9	18	7,020,538	1,178,651	16.8	13,462,317	.52
Ohio	36	55	6,744,907	1,355,447	20.1	37,739,322	.18
Illinois	34	72	4,574,565	890,436	19.5	2,316,646	1.97
Kentucky	5	6	3,330,986	660,108	19.8	19,816,518	.17
Kansas	5	11	2,389,856	593,730	24.8	16,023,067	.15
Wyoming	2	3	1,579,526	268,339	17.0	1,433,564	1.10
New York	5	4	218,131	55,405	25.4	99,487	2.19
Colorado			2,475	620	25.1	619	4.00
	[a] 503	1,004	282,535,550	50,363,535	17.8	449,108,661	.63

[a] Irrespective of the kind, number, and location of the plants operated. The sum of the number of operators listed for each State will therefore not give the actual number of operators in the United States. The number of operators shown for 1918 is not comparable with earlier years, as a change has been made in the method of arriving at this number.

1919: The production of natural-gas gasoline in 1919 was 351,535,026 gallons, valued at $64,196,763. Figures by States are shown in tables on pages 126A to 153A.

GEMS AND PRECIOUS STONES.

PRODUCTION.

Value of precious stones produced in the United States, 1913–1919.

Variety.	1913	1914	1915	1916	1917	1918	1919
Beryl	$1,615	$2,395	$1,675	$2,031	$2,178	$1,906	(a)
Copper ore gems	2,350	1,280	1,120	1,713	2,857	2,299	(a)
Corundum	238,835	61,032	88,214	99,180	54,204	42,414	$40,304
Diamond	6,315	765	608	2 680	4,175	1,910	(a)
Feldspar	1,285	449	368	305	(a)	(a)	(a)
Garnet	4,285	1,760	4,523	1,542	624	1,277	1,630
Hematite	.....	.....	126	(a)	(a)	138	(a)
Jade	.....	300	.....	.....	.....	.....	.....
Opal	15,130	1,114	1,850	1,838	805	6,304	(a)
Peridot	375	100	(a)	455	(a)	1,018	.....
Pyrite	50	.....	1,042	2,075	(a)	(a)	.....
Quartz	16,861	18,838	35,724	25,707	28,273	15,211	17,632
Rhodonite	165	1,050	85	(a)	(a)	515	160
Smithsonite	50	50	(a)	.....	(a)	.....	.....
Spodumene	6,520	4,000	(a)	(a)	(a)	281	(a)
Thomsonite	.....	21	(a)	47	(a)	(a)	(a)
Topaz	736	1,380	862	1,005	230	987	210
Tourmaline	7,630	7,980	10,969	50,807	12,452	6,206	17,700
Turquoise	8,075	13,370	11,691	21,811	14,171	20,667	22,750
Variscite	6,105	5,055	3,867	3,140	2,350	753	925
Vesuvianite	152	1,425	1,535	(a)	2,765	320	.....
Miscellaneous	2,920	2,287	6,172	3,457	5,928	4,397	10,452
	319,454	124,651	170,431	217,793	131,012	106,523	111,763

a Included under "Miscellaneous."

IMPORTS.

Value of diamonds and other precious stones imported and entered for consumption in the United States, 1913–1919.

Year.	Diamonds.				Other stones not set.	Total, excluding pearls.	Pearls.
	Glazier's.	Dust and bort.	Rough or uncut.	Cut but not set.			
1913	$471,712	$100,704	$12,268,543	$24,812,604	$2,805,963	$40,459,526	$5,002,624
1914	579,332	77,408	2,851,933	11,976,871	1,649,875	17,135,419	2,090,018
1915	366,793	75,944	7,020,646	13,177,919	1,078,391	21,719,693	4,513 909
1916	836,018	67,290	11,441,328	24,282,140	2,303,351	38,930,127	11,336,971
1917	1,098,102	349,746	13,092,855	18,421,838	1,883,810	34,846,351	4,947,509
1918	718,397	475,870	12,636,024	7,734,150	1,102,398	22,666,839	765,929
1919	984,381	1,420,442	20,306,758	64,085,610	5,161,639	91,958,830	11,008,973

EXPORTS.

No domestic exports are recorded.

Value of foreign precious stones reexported from the United States, 1913–1919.

Year.	Diamonds.			Other precious stones.		Total, excluding pearls.	Pearls and parts of, not strung or set.
	Uncut.	Cut but not set.	Bort.	Uncut.	Cut but not set.		
1913	$1,870	$57,117	(a)	$1,707	$7,239	$67,933	$24,787
1914	14,809	20,350	(a)	2,573	53,086	90,818	1,066
1915	97,764	5,119	$2,470	661	10,554	116,568	116,809
1916	6,979	9,342	4	9,023	48,352	73,700	894,115
1917	7,757	400	14,962	1,512	16,842	41,473	20,353
1918	.....	.....	56	100	57	213	42,908
1919	3,238	25,000	(b)	b 15,652	1,783	45,673	5,386

a No figures available. b Bort included under "Other precious stones—uncut."

GOLD AND SILVER.

PRODUCTION.

Gold and silver produced in the United States, 1913–1919.

Year.	Gold.		Silver.	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Commercial value.
1913	4,299,783	$88,884,400	66,801,500	$40,348,100
1914	4,572,976	94,531,800	72,455,100	40,067,700
1915	4,887,602	101,035,700	74,961,075	37,397,300
1916	4,479,056	92,590,300	74,414,802	48,953,000
1917	4,051,440	83,750,700	71,740,362	59,078,100
1918	3,320,784	68,646,700	67,810,139	66,485,129
1919	2,918,628	60,333,400	56,682,445	63,533,652

According to tables published by the Director of the Mint the total production of gold and silver in the United States is as follows:

Gold and silver produced in the United States, 1792–1919.

[The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint.]

Period.	Gold.		Silver.	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Commercial value.
1792–1847	1,186,977	$24,537,000	309,500	$404,500
1848–1872	58,279,781	1,204,750,000	118,568,200	157,749,900
1873–1919	136,049,899	2,812,401,000	2,385,152,323	1,866,878,081
	195,516,657	4,041,688,000	2,504,030,023	2,025,032,481

Gold produced in the United States, 1918 and 1919, by States. [a]

State.	1918		1919	
	Quantity (troy ounces).	Value.[b]	Quantity (troy ounces).	Value.[b]
Alabama	34	$700	.....	.....
Alaska	455,920	9,424,700	481,984	$9,963,500
Arizona	270,078	5,583,000	222,965	4,609,100
California	811,945	16,784,400	841,638	17,398,200
Colorado	615,558	12,724,700	495,810	10,249,300
Georgia	218	4,500	34	700
Idaho	33,930	701,400	34,085	704,600
Maine	34	700	10	200
Missouri	3	60	14	300
Montana	158,704	3,280,700	116,918	2,416,900
Nevada	324,134	6,700,440	225,384	4,659,100
New Mexico	33,237	687,080	28,319	585,400
North Carolina	213	4,400	5	100
Oregon	61,228	1,265,700	53,029	1,096,200
Philippine Islands	62,404	1,290,000	41,119	850,000
Porto Rico	5	100	.....	.....
South Carolina	.....	.....	5	100
South Dakota	324,083	6,699,400	255,889	5,289,700
Tennessee	271	5,600	271	5,600
Texas	1	20	19	400
Utah	152,526	3,153,000	109,661	2,266,900
Vermont	48	1,000	19	400
Virginia	19	400	.....	.....
Washington	16,148	333,800	11,436	236,400
Wyoming	43	900	14	300
	3,320,784	68,646,700	2,918,628	60,333,400

[a] Figures of production issued jointly by the Bureau of the Mint and the Geological Survey.
[b] Gold value, $20.67+ a troy ounce.

Silver produced in the United States, 1918 and 1919, by States.[a]

State.	1918		1919	
	Quantity (troy ounces).	Value.[b]	Quantity (troy ounces).	Value.[b]
Alabama	2	$2		
Alaska	802,743	787,057	690,151	$773,570
Arizona	6,831,465	6,697,978	5,702,911	6,392,222
California	1,432,812	1,404,815	1,153,614	1,293,051
Colorado	6,900,266	6,765,435	5,966,606	6,687,790
Georgia	45	44	8	9
Idaho	9,396,009	9,212,411	5,933,076	6,650,207
Illinois	8,218	8,057	6,000	6,725
Maine	6,338	6,214	4,142	4,643
Maryland	164	161		
Michigan	516,294	506,206	425,610	477,054
Missouri	42,214	41,389	75,991	85,176
Montana	16,378,263	16,058,232	15,012,258	16,826,790
Nevada	9,931,969	9,737,898	7,045,395	7,896,972
New Hampshire	691	678		
New Mexico	773,662	758,545	851,821	954,781
North Carolina	100	98	19	21
Oregon	129,150	126,626	236,620	265,220
Philippine Islands	13,000	12,746	15,715	17,614
South Carolina			2	2
South Dakota	161,232	158,082	122,068	136,822
Tennessee	105,829	103,761	97,554	109,345
Texas	579,158	567,841	539,483	604,690
Utah	13,492,555	13,228,911	12,542,623	14,058,650
Vermont	4,891	4,795	2,200	2,466
Virginia	1,814	1,779	8	9
Washington	300,000	294,138	258,270	289,487
Wyoming	1,255	1,230	300	336
	67,810,139	66,485,129	56,682,445	63,533,652

[a] Figures of production issued jointly by the Bureau of the Mint and the Geological Survey.
[b] Valued at the average New York price of fine silver—$0.98 an ounce in 1918 and $1.12 in 1919.

World's production of gold, 1913–1918, by countries.

[Figures supplied by U. S. Bureau of the Mint.]

Country.	1913	1914	1915	1916	1917	1918
North America:						
United States	$88,884,400	$94,531,800	$101,035,700	$92,590,300	$83,750,700	$68,646,700
Canada	16,598,900	15,983,004	18,977,901	19,235,000	15,273,000	14,687,900
Mexico	19,308,800	4,788,175	6,559,275	7,690,700	9,000,000	16,824,700
Africa	207,326,500	201,996,796	217,851,898	222,948,900	214,304,300	197,073,600
Australasia	53,113,200	47,569,023	48,988,177	40,475,800	34,398,100	29,268,600
Europe:						
Russia, Finland, and Siberia	26,508,700	28,586,392	26,322,746	22,500,000	18,000,000	12,000,000
Austria-Hungary	2,179,300	200,744	1,392,465	1,000,000	150,000	180,000
Germany	135,600					
Sweden	17,600	54,304	25,323	12,200	10,000	10,000
Italy	17,200	32,145	2,295	2,000	700	22,800
Spain and Portugal	2,300	2,336	661			
Turkey	500	475	475			
France	2,127,400	1,400,000	1,400,000	1,000,000	700,000	500,000
Great Britain	17,900	20,238	19,266	5,700	5,000	
Serbia	328,000	116,000				
South America:						
Argentina	2,600			15,300	4,600	4,000
Bolivia and Chile	336,884	202,770	814,418	301,000	770,700	770,000
Colombia	2,971,700	4,678,587	5,453,148	6,173,900	5,000,000	4,866,500
Ecuador	406,500	346,853	545,674	560,000	887,800	800,000
Brazil	2,254,700	2,139,803	2,424,515	2,890,000	2,958,000	2,800,000
Venezuela	419,040	564,220	1,395,349	1,269,900	636,900	473,200

World's production of gold, 1913–1918, by countries—Continued.

Country.	1913	1914	1915	1916	1917	1918
South America—Continued.						
Guiana:						
British	$1,353,500	$1,126,500	$923,892	$660,700	$519,000	$400,000
Dutch	470,400	503,400	449,054	438,200	445,000	322,200
French	3,050,600	1,959,793	1,959,793	1,600,000	1,438,500	1,100,000
Peru	912,280	1,022,125	1,109,891	1,267,400	1,254,100	1,250,000
Uruguay	29,900	15,276	11,836	12,000	10,000	10,000
Central America	2,721,700	2,393,190	2,970,271	3,517,600	3,122,000	3,400,000
Asia:						
Japan	3,614,400	4,679,358	5,386,066	5,185,600	4,679,700	5,105,900
China	3,658,900	3,658,900	2,804,692	3,100,700	3,600,100	3,600,000
Indo-China	74,700	66,419	43,659	65,600	50,000	50,000
Chosen (Korea)	3,582,500	3,309,870	3,739,477	4,122,400	3,363,800	3,300,000
Siam	56,500					
India, British	12,178,000	11,378,400	11,522,457	11,206,500	10,812,800	10,028,000
East Indies, British	1,352,000	4,480,853	3,100,000	3,000,000	2,853,700	2,571,400
East Indies, Dutch	3,387,100					
Federated Malay States	282,400	269,147	351,527	327,900	342,400	345,300
Formosa	814,600	952,806	1,143,017	1,001,200	1,081,200	513,700
	460,497,204	439,029,702	468,724,918	454,176,500	419,422,100	380,924,500

World's production of silver, 1913–1918, by countries, in troy ounces.

[Figures supplied by U. S. Bureau of the Mint.]

Country.	1913	1914	1915	1916	1917	1918
North America:						
United States	66,801,500	72,455,100	74,961,075	74,414,800	71,740,400	67,810,100
Canada	31,524,708	28,406,711	26,625,960	25,459,700	22,221,300	21,284,600
Mexico	70,703,828	27,546,752	39,570,151	22,838,400	35,000,000	62,517,000
Central America	2,135,641	2,754,868	2,920,496	2,602,500	2,369,500	2,900,000
South America:						
Bolivia and Chile	3,932,594	789,685	3,870,065	4,402,100	4,151,600	4,335,000
Argentina	35,271			21,300	29,000	25,000
Brazil	28,364	76,685	21,523	22,000	25,000	25,000
Colombia	587,683	351,271	351,271	309,400	325,000	325,000
Ecuador	22,642	16,726	24,655	30,000	45,000	40,000
Peru	9,971,067	9,214,190	9,419,950	10,787,000	10,864,400	10,800,000
Guiana and Uruguay	51,111			8,500	8,000	8,000
Venezuela					3,300	3,000
Europe:						
Austria-Hungary	2,104,107	1,572,746	1,772,699	1,500,000	1,500,000	1,750,000
Germany	4,984,677					
France	520,766					
Great Britain	128,543	135,458	96,450	86,500	75,000	50,000
Greece	803,750	591,464	591,464	350,000	350,000	350,000
Italy	423,888	510,365	493,856	486,500	486,500	500,000
Norway	247,988	440,917	413,867	439,100	294,900	270,200
Spain and Portugal	4,437,637	4,434,417	4,567,454	4,517,800	2,850,000	3,100,000
Russia			638,403	550,000	500,000	400,000
Serbia	28,758	12,014		10,000	20,000	20,000
Sweden	58,969	33,511	24,230	37,900	35,000	31,500
Turkey	1,509,133	1,509,133	1,509,133	500,000	400,000	400,000
Australasia	18,128,577	11,000,000	9,250,000	10,700,000	10,000,000	10,000,000
Asia:						
British India		236,440	284,875	280,000	275,000	270,000
China			18,230	30,000	63,900	70,000
Chosen (Korea)	15,048	16,864	21,897	25,000	26,500	26,000
Dutch East Indies	465,980	400,000	400,000	400,000	400,000	400,000
Indo-China		1,767	1,056	1,000	1,000	1,000
Formosa	51,763	51,080	47,653	47,700	39,600	26,900
Japan	4,649,910	4,836,228	5,120,293	5,805,700	7,111,700	6,600,400
Burma				977,100	1,793,700	1,970,500
Africa:						
Belgian Kongo	1,454	4,770	4,770	11,000	10,300	10,500
Egypt		1,223	1,657	1,200	900	800
French East Africa						
Madagascar				20,000	20,000	20,000
Rhodesia	121,537	150,794	185,233	200,700	212,000	175,700
Transvaal, Cape Colony, Natal	933,191	901,763	996,379	968,900	938,100	877,500
Portuguese East Africa				1,200	1,200	1,200
	225,410,085	168,452,942	184,204,745	168,843,000	174,187,800	197,394,900

IMPORTS AND EXPORTS.

Value of gold and silver imported into and exported from the United States, 1918 and 1919.

1918.

	Imports.	Exports.	Excess of—	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$206,674		$206,674
Contained in foreign ore and base bullion	$16,251,930		$16,251,930	
Domestic bullion refined		8,052,578		8,052,578
Foreign bullion refined	38,911,037		38,911,037	
United States coin	6,743,464	32,431,889		25,688,425
Foreign coin	136,317	378,677		242,360
	62,042,748	41,069,818	55,162,967	34,190,037
Excess imports over exports			20,972,930	
SILVER.				
Contained in domestic ore and base bullion		18,248		18,248
Contained in foreign ore and base bullion	44,877,920		44,877,920	
Domestic bullion refined		236,411,329		236,411,329
Foreign bullion refined	20,619,195	6,916,337	14,002,858	
United States coin	1,267,857	3,542,926		2,275,069
Foreign coin	4,610,747	6,857,624		2,246,877
	71,375,699	252,846,464	59,480,778	240,951,543
Excess exports over imports				181,470,765

1919.

GOLD.				
Contained in domestic ore and base bullion		$20,719		$20,719
Contained in foreign ore and base bullion	$16,744,430		$16,744,430	
Domestic bullion refined		122,055,164		122,055,164
Foreign bullion refined	33,183,373		33,182,373	
United States coin	11,244,897	245,496,208		234,251,311
Foreign coin	15,361,346	613,157	14,748,189	
	76,534,046	368,185,248	64,675,992	356,327,194
Excess exports over imports				291,651,202
SILVER.				
Contained in domestic ore and base bullion		6,693		6,693
Contained in foreign ore and base bullion	74,073,332	1,252	74,072,080	
Domestic bullion refined		186,533,723		186,533,723
Foreign bullion refined	8,482,020	23,644,997		15,262,967
United States coin	1,057,135	21,224,827		20,167,692
Foreign coin	5,807,521	7,909,559		1,712,038
	89,419,018	239,021,051	74,072,080	223,683,113
Excess exports over imports				149,611,033

PRICES.

Gold is valued by law at $20.67 + a troy ounce.
For prices of silver, see statement on page 12A.

GRAPHITE.

PRODUCTION.

Crystalline graphite sold in the United States, 1917–1919, by States.

State.	1917		1918		1919	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Alabama	6,223,095	$719,575	7,795,475	$999,152	3,569,030	$272,413
New York	2,941,040	261,548	3,266,518	273,188	(a)	(a)
Pennsylvania	804,945	77,475	1,016,900	112,059	484,060	26,003
Other States [a]	615,000	35,800	782,946	70,400	4,033,101	432,725
	10,584,080	1,094,398	12,861,839	1,454,799	8,086,191	731,141

[a] 1917: Alaska, California, Montana, and Texas; 1918: California, Montana, and Texas; 1919: California, New York, and Texas.

Domestic natural graphite sold in the United States, 1913–1919.

Year.	Amorphous.		Crystalline.		Total.	
	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quantity (short tons).	Value.
1913	2,243	$39,428	5,064,727	$254,328	4,775	$293,756
1914	1,725	38,750	5,220,539	285,368	4,335	324,118
1915	1,181	12,358	7,074,370	417,273	4,718	429,631
1916	2,622	20,723	10,931,989	914,748	8,088	935,471
1917	8,301	73,481	10,584,080	1,094,398	13,593	1,167,879
1918	6,560	69,455	12,861,839	1,454,799	12,991	1,524,254
1919	3,379	47,716	8,086,191	731,141	7,422	778,857

World's production of natural graphite, 1913–1919, in metric tons.

	1913	1914	1915	1916	1917	1918	1919
United States: [a]							
Amorphous	2,035	1,565	1,071	2,378	7,530	5,951	3,065
Crystalline	2,297	2,368	3,209	4,959	4,801	5,834	3,668
Canada [a]	1,961	1,495	2,391	3,588	3,369	2,826	1,199
Mexico [b]	4,023	3,865	1,525	4,836	6,869	5,080	4,995
Brazil [b]	2½	.....	2	1	15	45	2
Austria and Styria	17,282	11,062	14,815	[c] 21,000	[c] 18,000	17,415	[c] 17,000
Bohemia and Moravia	32,175	26,973	20,231	26,313	29,073	27,355	31,234
France	1,194	300	.....	.....	1,650	2,132	375
Germany	12,057	13,619	17,292	30,574	42,825	64,080	(d)
Italy	11,145	8,567	6,176	8,182	12,117	11,653	7,626
Spain	.....	.....	30	1,240	1,980	710	1,958
Sweden	88	56	87	194	4	102	.....
Ceylon [b]	28,996	14,463	22,173	33,956	27,572	15,701	6,504
French Indo-China [b]	.....	.....	.....	.....	8,000	15,000	(d)
British India	.....	.....	71	1,525	105	82	129
Japan	667	573	666	1,149	1,331	1,886	(d)
Chosen (Korea) [b]	14,543	9,149	7,044	16,963	16,183	13,659	[c] 12,000
Madagascar	7,997	11,232	15,940	26,524	35,000	16,000	2,000
Union of South Africa	35	31	37	55	78	72	78
Australia	.....	7	71	72	89	208	102
	136,497½	105,325	112,831	183,509	216,591	205,791	.....

[a] Shipments and sales. [b] Exports. [c] Estimated. [d] No data.

IMPORTS.

Graphite imported for consumption in the United States, 1913–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1913	28,879	$2,109,791	1917	42,577	$8,961,988
1914	21,990	1,398,209	1918	19,498	3,092,475
1915	23,075	2,241,163	1919	26,626	2,978,096
1916	42,930	7,279,884			

EXPORTS.

Graphite exported from the United States, 1913–1919.

Year.	Unmanufactured graphite.		Manufactures of graphite.
	Quantity (pounds).	Value.	
1913	5,383,981	$391,906	$238,302
1914	3,920,693	277,386	215,878
1915	1,057,764	52,583	536,572
1916	1,595,608	98,118	1,339,259
1917	5,146,816	349,563	891,687
1918	1,907,719	121,555	731,518
1919	1,258,040	90,185	788,755

PRICES.

Prices of best grades of domestic flake graphite (sales at mines) and Ceylon lump (New York prices), in cents per pound, 1911–1919.

Year.	Domestic flake.	Ceylon lump.	Year.	Domestic flake.	Ceylon lump.
1911	6 – 7	8¼– 9	1916	10–16	20 –28
1912	6 – 7	8½–10	1917	12–18	28 –32
1913	6 – 8	9½–11	1918	10–17¾	15½–28½
1914	6½– 8	6½– 9½	1919	4–10½	14 –15½
1915	7 –10	9⅝–20			

GRINDSTONES AND PULPSTONES.

[See under Abrasive materials.]

GYPSUM.

PRODUCTION.

Gypsum produced in the United States, 1910–1919.

Year.	Crude (short tons).	Crude and calcined (total value).	Year.	Crude (short tons).	Crude and calcined (total value).
1910	2,379,057	$6,523,029	1915	2,447,611	$6,596,893
1911	2,323,970	6,462,035	1916	2,757,730	7,959,032
1912	2,500,757	6,563,908	1917	2,696,226	11,116,452
1913	2,599,508	6,774,822	1918	2,057,015	11,470,854
1914	2,476,465	6,895,989	1919	2,420,163	15,727,907

IMPORTS.

Gypsum imported into the United States comes almost wholly from Nova Scotia and New Brunswick and enters the ports of New England and the North Atlantic States.

Gypsum imported and entered for consumption in the United States, 1913–1919.

Year.	Unground.		Ground or calcined.		Value of manufactured plaster of Paris.	Keenes cement.		Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		Quantity (short tons).	Value.	
1913	447,383	$473,594	4,542	$31,277	$52,051	1,851	$26,185	$583,107
1914	369,214	392,118	3,559	27,931	24,792	1,007	17,511	462,352
1915	336,856	356,791	5,749	22,873	10,095	427	6,656	396,415
1916	254,131	275,043	11,706	72,345	9,085	600	9,890	366,363
1917	240,269	265,504	16,533	109,732	6,016	484	8,003	389,255
1918	50,653	55,004	6,117	70,028	1,765	111	2,259	129,056
1919	171,733	211,946	10,415	126,405	7,719	187	5,984	352,054

EXPORTS.

Exports of plaster of Paris in 1916 were valued at $13,076, and in the first six months of 1917 at $20,153. Figures are not available for any other period.

ILMENITE.

[See under Titanium minerals.]

IRON ORE, PIG IRON, AND STEEL.

IRON ORE.

PRODUCTION.

Iron ore[a] mined in the United States, by mining districts and varieties, in 1919, in long tons.

District.	Hematite.	Brown ore.	Magnetite.	Total.	Percentage of decrease in 1919 from 1918.
Lake Superior[b]	52,392,339			52,392,339	12
Birmingham	4,253,167	277,865		4,531,032	11
Chattanooga	350,116	196,822		546,938	34
Adirondack			740,315	740,315	3
Northern New Jersey and southeastern New York			491,458	491,458	6
Other districts	[c]723,960	651,093	[c]886,666	2,261,719	15
	[c]57,719,582	1,125,780	[c]2,118,439	60,963,801	12

[a] Exclusive of ore containing 5 per cent or more of manganese.
[b] Includes only those mines in Wisconsin which are in the true Lake Superior district.
[c] Some magnetite included with hematite.

Iron ore mined in the United States, by varieties, 1913–1919, in long tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1913	57,933,251	1,682,063	2,357,274	7,849	61,980,437
1914	38,286,670	1,537,750	1,610,203	5,138	41,439,761
1915	52,227,324	1,488,709	1,807,002	3,455	55,526,490
1916	70,728,024	1,904,484	2,533,364	1,800	75,167,672
1917	70,743,513	1,992,332	2,553,006		75,288,851
1918	65,894,709	1,613,844	2,149,725		69,658,278
1919	[a]57,719,582	1,125,780	[a]2,118,439		60,963,801

[a] Some magnetite included in hematite.

Iron ore mined in the Lake Superior district, by ranges, 1913–1919, in long tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1913	3,977,808	4,997,246	4,743,515	1,536,115	36,378,671	744,007	52,377,362
1914	3,320,763	3,671,499	4,601,240	1,362,416	19,808,434	776,051	33,540,403
1915	3,817,892	4,665,465	4,996,237	1,541,645	30,802,409	1,120,606	46,944,254
1916	4,792,987	6,649,578	7,707,101	1,704,440	41,325,341	1,555,641	63,735,088
1917	4,638,374	6,366,483	7,881,232	1,481,301	41,127,323	1,986,608	63,481,321
1918	3,946,554	6,041,637	7,837,634	1,192,677	39,055,977	1,705,315	59,779,794
1919	4,158,751	4,863,968	7,368,994	1,051,795	33,262,954	1,685,877	52,392,339

Iron ore shipped from mines in the United States, 1918 and 1919, by States.

State.	1918		1919		Increase or decrease in 1919.		Percentage of increase or decrease in 1919.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity.	Value.
Alabama	6,121,087	$15,334,561	4,895,309	$11,954,425	− 1,225,778	−$3,380,136	− 20	− 22
California	3,121	14,683	2,053	13,796	− 1,068	− 887	− 34	− 6
Georgia	262,003	878,612	74,007	294,619	− 187,996	− 583,993	− 72	− 66
Maryland	6,070	23,686	(a)	(a)	(b)	(b)	(b)	(b)
Michigan	17,587,416	65,900,501	12,911,727	49,774,212	− 4,675,689	−16,126,289	− 27	− 24
Minnesota	43,263,240	144,706,532	34,547,356	121,107,247	− 8,715,884	−23,599,285	− 20	− 16
Missouri	71,968	270,337	53,626	223,144	− 18,342	− 47,193	− 25	− 17
New Jersey	375,238	1,945,651	336,629	1,712,255	− 38,609	− 233,396	− 10	− 12
New Mexico	275,266	546,212	224,553	506,538	− 50,713	− 39,674	− 18	− 7
New York	899,970	5,802,870	701,688	4,002,312	− 198,282	− 1,800,558	− 22	− 31
North Carolina	108,332	604,592	58,778	231,530	− 49,554	− 373,062	− 46	− 62
Pennsylvania	515,845	982,173	616,271	1,340,219	+ 100,426	+ 358,046	+ 19	+ 36
Tennessee	408,954	1,184,546	282,988	817,549	− 125,966	− 366,997	− 31	− 31
Utah	52,722	168,438	44,185	177,327	− 8,537	+ 8,889	− 16	+ 5
Virginia	400,135	1,365,582	304,920	1,139,349	− 95,215	− 226,233	− 24	− 17
Wisconsin	1,167,640	3,796,408	881,740	3,253,290	− 285,900	− 543,118	− 24	− 14
Other States c	502,195	842,763	435,337	748,470	− b 72,928	− b 117,979	−b 14	−b 14
	72,021,202	244,368,147	56,371,167	197,296,282	−15,650,035	−47,071,865	− 22	− 19

a Less than three shippers in Maryland in 1919 and permission not granted to publish State total. Figures for this State therefore included under "Other States."

b Decrease for Maryland included with those for "Other States."

c 1918: Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, Texas, Washington, and Wyoming; 1919: Colorado, Connecticut, Idaho, Maryland, Massachusetts, Montana, Texas, Washington, and Wyoming.

Iron ore produced in some principal countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Source of data.a
North America:							
Canada b	279,084	222,130	361,165	249,638	195,321	187,626	1913–1918, 1.
Cuba b	1,607,750	834,248	840,687	724,119	562,341	653,829	1913–1918, 2.
Newfoundland b	1,456,882	575,088	787,854	918,135	801,366	769,821	1913–1918, 1.
United States	62,972,124	42,102,797	56,414,914	76,370,355	76,493,473	70,772,810	1913–1918, 2.
South America:							
Chile	14,100	63,506	147,100	56,166	5,000	2,743	1913–1917, 3; 1918, 2.
Venezuela c	58,141	2,438					1913–1914, 4.

a 1, Canada Dept. Mines, Mines Branch; 2, U. S. Geological Survey; 3, Anuario estadístico de la República de Chile; 4, Bur. Foreign and Domestic Commerce; 5, National Federation of Iron and Steel Manufacturers (London); 6, Statistique des industries extractives et métallurgiques; 7, Statistique de l'industrie minérale; 8, Vierteljahrshefte zur Statistik; 9, Tableaux statistiques du mouvement minier; 10, Rivista del servizio minerario; 11, Norges Officielle Statistik; 12, Russian Gornago Department of Mining and Metallurgical Industries; 13, Estadística minera de España; 14, Bergshantering Sveriges Officiella Statistik; 15, Mines and Quarries (London); 16, Iron Trade Review; 17, Report on the iron situation in France, by Ernest L. Ives, American consul, Paris.

b Shipments.

c Exports.

Iron ore produced in some principal countries, 1913–1918, in metric tons—Continued.

Country.	1913	1914	1915	1916	1917	1918	Source of data.[a]
Europe:							
Austria-Hungary	5,318,531	4,182,421	[b]1,238,268	(c)	(c)	(c)	1913–1915, 5.
Belgium	150,450	82,360	4,720	30,430	17,000	500	1913–1918, 6.
France	21,917,870	11,251,753	620,254	1,680,684	2,034,721	1,671,851	1913, 7; 1914–1918, 17.
Germany	28,607,903	20,505,000	17,710,000	(c)	(c)	(c)	1913, 8; 1914–1915, 5.
Greece	313,578	299,286	157,430	84,985	63,364	(c)	1913–1917, 9.
Italy	603,116	706,246	679,970	942,244	993,825	(c)	1913–1917, 10.
Luxemburg	7,333,382	5,007,457	6,139,434	6,752,207	4,509,150	(c)	1913–1917, 5.
Norway	544,443	652,273	714,917	879,840	(c)	(c)	1913, 11; 1914–1916, 5.
Portugal	49,182	6,639	(c)	(c)	(c)	(c)	1913–1914, 5.
Russia	9,513,945	(c)	(c)	(c)	(c)	(c)	1913, 12.
Spain	9,861,668	6,819,964	5,617,839	5,856,861	5,551,071	(c)	1913–1917, 13.
Sweden	7,475,571	6,586,630	6,883,308	6,986,298	6,217,172	(c)	1913–1917, 14.
United Kindgom	16,253,285	15,105,463	14,462,772	13,710,573	15,083,266	15,285,083	1913–1917, 15; 1918, 5.
Asia:							
China	[d] 423,003	[d] 496,071	545,819	278,555	304,356	(c)	1913–1914, 16; 1915–1917, 5.
Chosen (Korea)	142,012	181,987	209,883	245,355	(c)	(c)	1913–1916, 4.
India	376,779	448,741	396,514	418,346	419,885	(c)	1913–1917, 5.
Japan	171,656	136,385	136,121	158,815	(c)	(c)	1913–1916, 4.
Africa:							
Algeria	1,348,899	1,115,021	818,705	938,684	1,065,502	782,047	1913, 7; 1914–1918, 5.
Morocco	(c)	(c)	189,190	(c)	(c)	(c)	1915, 5.
Tunis	594,199	248,522	285,899	367,499	606,000	(c)	1913–1917, 5.
Australia	(c)	180,785	376,821	396,350	490,236	(c)	1914–1917, 5.

[a] See footnote [a], p. 69A.
[b] Hungary only.
[c] Statistics not available.
[d] From Tayeh deposits only.

STOCKS.

Stocks of iron ore at mines in the United States, Dec. 31, 1917 and 1918, in long tons.

State.	1917	1918	State.	1917	1918
Alabama	617,222	242,781	New Mexico	7,700	.....
California	14	.....	New York	61,647	35,049
Georgia	20,654	10,025	North Carolina	40	.....
Iowa	5,113	12,165	Ohio	3,388	.....
Maryland	2,130	4,141	Pennsylvania	34,961	41,593
Massachusetts	2,950	1,172	Virginia	30,613	44,527
Michigan	4,946,986	4,368,909	Wisconsin	310,557	232,250
Minnesota	4,802,634	3,365,540			
Missouri	2,320	1,985		11,003,843	8,565,893
New Jersey	154,914	205,756			

1919: Total stocks of iron ore for 1919 were 13,097,500 long tons. Detailed figures are shown on page 626.

IMPORTS AND EXPORTS.

Iron ore imported into and exported from the United States, 1913–1919.

Year.	Imports.		Exports.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	2,594,770	$8,336,819	1,042,151	$3,513,419
1914	1,350,588	4,483,832	551,618	1,794,193
1915	1,341,281	4,181,645	707,641	2,181,629
1916	1,325,736	4,566,514	1,183,952	3,702,496
1917	971,663	3,655,392	1,132,313	4,464,111
1918	787,468	3,464,304	1,256,383	5,535,090
1919	476,461	2,385,689	996,569	4,308,746

PRICES.

Average price of iron ore per long ton at the mines in the United States, 1913–1919.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	General average.
1913	$2.21	$1.88	$2.07	$2.06	$2.19
1914	1.79	1.72	2.39	2.44	1.81
1915	1.80	1.80	2.50	2.44	1.83
1916	2.32	2.03	3.11	3.00	2.34
1917	3.12	2.95	4.29	.....	3.15
1918	3.35	3.51	4.60	.....	3.39
1919	3.48	3.62	4.08	.....	3.50

Selling prices of iron ore per long ton at lower Lake ports at date of buying movement, 1913–1919.[a]

Season.	Date of buying movement.	Season iron-ore prices.			
		Old range Bessemer.	Mesabi Bessemer.	Old range non-Bessemer.	Mesabi non-Bessemer.
1913	Nov. 19, 1912	$4.40	$4.15	$3.60	$3.40
1914	May 1, 1914	3.75	3.50	3.00	2.85
1915	Apr. 19, 1915	3.75	3.45	3.00	2.80
1916	Dec. 7, 1915	4.45	4.20	3.70	3.55
1917	Nov. 22, 1916	5.95	5.70	5.20	5.05
1918	Apr. 1, 1918	5.95	5.70	5.20	5.05
	July 1, 1918	6.40	6.15	5.65	5.50
	Oct. 1, 1918	6.65	6.40	5.90	5.75
1919	Apr. 28, 1919	6.45	6.20	5.70	5.55

[a] Iron Trade Review.

PIG IRON.

PRODUCTION.

Pig iron shipped from blast furnaces in the United States, 1917 and 1918, by States.

State.	1917		1918		Change in 1918.		Percentage of change, 1918.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity.	Value.
Alabama	2,971,626	$64,309,714	2,645,179	$80,893,687	− 326,447	+$16,583,973	− 11.0	+ 25.8
Illinois	3,458,126	91,094,541	3,409,876	105,415,030	− 48,250	+ 14,320,489	− 1.4	+ 15.7
Indiana	(a)	(a)	2,583,375	75,149,991	(b)	(b)	(b)	(b)
Kentucky	192,204	5,532,367	234,952	8,031,994	+ 42,748	+ 2,499,627	+ 22.2	+ 45.2
Michigan	611,446	18,300,501	502,884	17,823,684	− 108,562	− 476,817	− 17.8	− 2.6
Missouri	(a)	(a)	83,432	3,084,136	(b)	(b)	(b)	(b)
New Jersey	187,753	6,618,536	222,418	7,611,885	+ 34,665	+ 993,349	+ 18.5	+ 15.0
New York	2,276,367	52,318,661	2,482,450	70,167,542	+ 206,083	+ 17,848,881	+ 9.1	+ 34.1
Ohio	8,469,052	231,165,093	8,711,205	263,189,621	+ 242,153	+ 32,024,528	+ 2.9	+ 13.9
Pennsylvania	15,423,262	460,677,474	14,701,252	465,859,029	− 722,010	+ 5,181,555	− 4.7	+ 1.1
Tennessee	346,638	9,102,441	342,538	11,672,606	− 4,100	+ 2,570,165	− 1.2	+ 28.2
Virginia	562,299	15,703,295	453,863	15,430,473	− 108,436	− 272,822	− 19.3	− 1.7
Wisconsin	402,732	11,032,274	363,225	13,832,908	− 39,507	+ 2,800,634	− 9.8	+ 25.4
Other States [c]	3,711,041	87,931,078	1,493,791	42,596,979	+[b]449,557	+[b]32,900,028	+[b]12.1	+[b]37.4
	38,612,546	1,053,785,975	38,230,440	1,180,759,565	− 382,106	+126,973,590	− 1.0	+ 12.0

[a] Included under "Other States."
[b] Increases in Indiana and Missouri included under "Other States."
[c] 1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia.

1919: Total shipments of pig iron for 1919 were 30,130,231 long tons, valued at $775,915,043. Detailed figures are shown on page 640.

Pig iron shipped from blast furnaces in the United States, 1910–1919.[a]

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1910	[a] 26,674,123	[a] $412,162,486	1915	30,384,486	$401,409,604
1911	23,257,288	327,334,624	1916	39,126,324	663,478,118
1912	30,180,969	420,563,388	1917	38,612,546	1,053,785,975
1913	30,388,935	458,342,345	1918	38,230,440	1,180,759,565
1914	22,263,263	298,777,429	1919	30,130,231	775,915,043

[a] Includes ferroalloys in 1910 only.

Pig iron produced in some principal countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Source of data.[a]
United States	31,461,610	23,705,560	30,394,872	40,065,754	39,239,155	39,679,518	1913–1918, 1.
United Kingdom	10,424,480	9,066,553	8,863,137	9,062,181	9,487,514	9,184,060	1913–1917, 2; 1918, 3.
Germany	19,309,172	14,389,852	11,789,931	13,284,738	13,142,247	[b]11,758,967	1913–1918, 4.
France	5,207,197	4,500,000	1,300,000	1,447,000	1,684,023	1,261,670	1913, 5; 1914–1915, 6; 1916, 4; 1917–1918, 3.
Russia	4,634,889	4,326,519	3,690,300	3,737,593	(c)	(c)	1913–1914, 7; 1915–1916, 4.
Austria-Hungary	2,380,864	1,988,000	1,959,084	2,418,322	(c)	(c)	1913–1916, 4.
Belgium	2,484,690	1,454,490	68,150	127,825	7,990	(c)	1913–1917, 8.
Canada	1,024,192	710,482	828,971	1,060,743	1,061,852	1,083,190	1913–1918, 9.
Sweden	736,330	646,122	770,051	743,031	838,948	749,800	1913–1917, 10; 1918, 4.
Spain	424,774	382,044	439,835	501,667	357,699	386,550	1913–1918, 11.
Italy	426,755	385,340	377,510	467,005	471,188	(c)	1913–1917, 12.
Japan	240,288	300,155	317,964	385,647	(c)	(c)	1913–1916, 13.
Philippine Islands	227	199	96	93	(c)	(c)	1913–1916, 14.
India	(c)	238,482	274,347	250,498	255,491	268,898	1914–1918, 4.
Australia	47,308	76,352	77,539	128,616	148,762	(c)	1913–1918, 4.
China	(c)	(c)	(c)	148,400	144,815	(c)	1916–1917, 4.

[a] 1, American Iron and Steel Institute; 2, Mines and Quarries (London); 3, Iron Age; 4, National Federation of Iron and Steel Manufacturers (London); 5, Statistique de l'industrie minérale; 6, Iron Trade Review; 7, General review of the principal branches of the mining and metallurgical industries (Russia); 8, Statistique des industries extractives et métallurgiques; 9, Canada Dept. Mines, Mines Branch; 10, Bergshantering Sveriges Officiella Statistik; 11, Estadistica minera de España; 12, Rivista del servizio minerario; 13, Bur. Foreign and Domestic Commerce; 14, Mineral resources of the Philippine Islands.

[b] Excludes Lorraine, Sarre district, and Luxemburg for November and December.

[c] Statistics not available.

IMPORTS.

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1913–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1913	156,450	$6,557,095	1917	76,786	$7,872,105
1914	138,903	4,694,186	1918	34,711	4,968,056
1915	89,836	4,108,180	1919	101,665	6,565,106
1916	135,349	10,239,868			

EXPORTS.

Pig iron exported from the United States, 1913–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1913	277,648	$4,026,306	1917	656,220	$24,037,051
1914	114,423	1,638,102	1918	269,575	11,576,721
1915	224,509	3,667,167	1919	321,261	12,313,183
1916	607,236	15,381,431			

PRICES.

Average monthly prices per ton of principal grades of pig iron in the United States, 1918 and 1919.[a]

Month.	1918				1919			
	Foundry pig iron at Valley furnaces.	Foundry pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.	Foundry pig iron at Valley furnaces.	Foundry pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.
January	$33.00	$33.00	$36.30	$33.00	$31.00	$31.00	$32.20	$30.00
February	33.00	33.00	36.30	33.00	31.00	31.00	32.20	30.00
March	33.00	33.00	36.13	32.85	27.88	28.44	30.73	28.53
April	33.00	33.00	35.20	32.00	26.75	26.75	27.95	25.75
May	33.00	33.00	35.20	32.00	26.75	25.28	27.95	25.75
June	33.00	33.00	35.20	32.00	26.75	25.14	27.95	25.09
July	33.00	33.00	35.20	32.00	26.75	26.01	27.95	25.75
August	33.00	33.00	35.20	32.00	26.75	27.18	27.95	25.75
September	33.20	33.20	35.20	32.20	26.75	27.50	27.95	25.75
October	34.00	34.00	35.20	33.00	26.90	27.78	27.95	25.75
November	34.00	34.00	35.20	33.00	30.76	30.21	29.44	27.83
December	34.00	33.16	35.20	33.00	35.46	34.81	35.27	33.88
Average	33.27	33.20	35.46	32.50	28.63	28.34	29.62	27.49

[a] Metal Statistics, 1920.

STEEL.

PRODUCTION.

Steel produced in the United States, 1911–1919, in long tons.[a]

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303
1913	9,545,706	21,599,931	121,226	34,011	31,300,874
1914	6,220,846	17,174,684	89,869	27,631	23,513,030
1915	8,287,213	23,679,102	113,782	70,939	32,151,036
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432
1919	7,271,562	26,948,694	63,572	387,404	34,671,232

[a] According to the American Iron and Steel Institute.

Steel produced in some principal countries, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Source of data.[a]
United States	31,801,688	23,889,238	32,665,453	43,458,059	45,781,577	45,173,831	1913–1918, 1.
United Kingdom	7,786,498	7,960,475	8,686,815	9,343,600	9,960,944	9,744,891	1913–1918, 2.
Germany	18,935,089	14,946,212	13,258,054	16,182,520	16,587,360	[b]14,875,753	1913–1918, 2.
France	4,686,866	3,250,000	870,000	1,952,000	2,231,651	1,809,771	1913, 3; 1914–1915, 4; 1916, 2; 1917–1918, 5.
Russia	4,868,140	4,782,965	4,900,000	(c)	(c)	(c)	1913–1914, 6; 1915, 2.
Austria-Hungary	2,625,879	2,160,239	2,674,197	3,330,306	2,920,789	1,763,745	1913–1916, 2; 1917–1918, 7.
Canada	1,060,503	751,738	926,151	1,295,699	1,583,719	1,717,318	1913–1918, 8.
Sweden	590,887	507,332	600,418	614,111	581,000	524,800	1913–1917, 9; 1918, 2.
Italy	933,500	911,000	1,009,240	1,269,486	1,331,641	(c)	1913–1917, 10.
India	(c)	67,669	105,130	133,189	165,314	185,186	1914–1918, 2.
Australia	(c)	24,811	63,349	110,144	158,121	(c)	1914–1917, 2.
Belgium	2,466,630	1,396,300	98,820	99,371	9,530	10,540	1913–1918, 11.
Japan	254,951	282,504	342,865	368,395	(c)	(c)	1913–1916, 12.

[a] 1, American Iron and Steel Institute; 2, National Federation of Iron and Steel Manufacturers (London); 3, Statistique de l'industrie minérale; 4, Iron Trade Review; 5, Iron Age; 6, General review of the principal branches of the mining and metallurgical industries (Russia); 7, Ironmonger; 8, Canada Dept. Mines, Mines Branch; 9, Bergshantering Sveriges Officiella Statistik; 10, Rivista del servizio minerario; 11, Statistique des industries extractives et métallurgiques; 12, Bur. Foreign and Domestic Commerce.

[b] Excludes Lorraine, Sarre district, and Luxemburg for November and December.

[c] Statistics not available.

LEAD.

SUPPLY.

Apparent consumption of refined primary lead in the United States (refinery stocks disregarded), 1913–1919, in short tons.

	1913	1914	1915	1916	1917	1918	1919
Supply:							
Stock in bonded warehouses Jan 1	47	.....	2	.....	535	2,685	472
Imports of pigs, bars, and old	41	148	410	5,655	5,793	5,240	5,107
Production	462,460	542,122	550,055	571,134	610,769	640,195	482,220
	462,548	542,270	550,467	576,789	617,097	648,120	487,799
Withdrawn:							
Exports of foreign lead:							
From warehouse	44,544	21,545	38,618	9,880	37,652	59,416	40,976
In manufactures, with benefit of drawback	9,779	9,489	3,983	5,171	7,537	3,426	1,936
Exports of domestic lead	.....	58,722	88,306	100,500	53,688	41,831	10,510
Stock in bonded warehouses Dec. 31	79	2	.....	535	2,685	472	234
	54,402	89,758	130,907	116,086	101,562	105,145	53,656
Apparent consumption	408,146	452,512	419,560	460,703	515,535	542,975	434,143

PRODUCTION.

REFINED LEAD.

Refined primary lead produced in the United States, 1913–1919, in short tons.

	1913	1914	1915	1916	1917	1918	1919
Domestic ore:							
Desilverized lead	250,578	311,069	301,564	316,469	303,679	282,024	208,751
Soft lead	131,867	158,219	161,461	167,515	188,503	210,463	147,744
Desilverized soft lead	29,433	43,506	44,001	68,244	56,268	47,418	67,938
Total from domestic ore	411,878	512,794	507,026	552,228	548,450	539,905	424,433
Foreign ore:							
Africa	5,976	2,942	.....	328	1,738	1,519	644
Australia	.....	.....	.....	.....	.....	282	69
Canada	16	2	1,174	1,231	1,100	7,550	1,895
Central America	.....	.....	1	7	.....	.....	12
Mexico	4,512	2,386	5,437	1,917	7,607	4,798	2,261
South America	2,617	1,821	2,829	2,366	1,533	1,101	2,537
Other foreign	102	488	140	236	3,894	84	238
Foreign base bullion:							
Canada	.....	.....	.....	1,072	6,750	8,108	567
Mexico	37,359	21,689	33,173	11,598	39,508	76,809	49,564
South America	.....	.....	275	151	189	39	.....
Total from foreign ore and base bullion	50,582	29,328	43,029	18,906	62,319	100,290	57,787
Grand total from all sources	462,460	542,122	550,055	571,134	610,769	640,195	482,220
Production of antimonial lead	16,665	16,667	23,224	24,038	18,646	18,570	13,874

Refined primary lead produced in the United States from domestic ores, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	375,402	$33,035,376	1915	507,026	$47,660,000
1911	391,995	35,279,550	1916	552,228	76,207,000
1912	392,517	35,326,530	1917	548,450	94,333,000
1913	411,878	36,245,264	1918	539,905	76,667,000
1914	512,794	39,998,000	1919	424,433	44,990,000

SECONDARY LEAD.

Secondary lead produced in the United States, 1913–1919, in short tons.

	1913	1914	1915	1916	1917	1918	1919
Pig lead	33,104	29,337	36,400	56,700	45,100	41,146	55,684
Lead in alloys	39,730	31,725	42,500	39,600	48,400	55,954	66,416
Total recovered lead	72,834	61,062	78,900	96,300	93,500	97,100	122,100

IMPORTS.

Lead imported into the United States in ore, base bullion, and refined, by countries, 1913–1919, in pounds.

[General imports.]

Country.	1913	1914	1915	1916	1917	1918	1919
United Kingdom	404,594	245,548	185,236	261,406	8,689,992	56,710	89,840
Germany	262,132	4,529,919	.....	.....	.....	.....	.....
Other European countries	143,293	123,085	32,537	314,353	255,907	5,800	.....
Total from Europe	810,019	4,898,552	217,773	575,759	8,945,899	62,510	89,840
British North America	338,569	384,007	2,303,170	12,606,216	11,738,379	28,225,878	10,391,115
Mexico	95,693,439	46,282,207	94,247,384	48,395,670	125,782,759	162,259,199	125,541,614
South America	8,766,327	2,417,744	5,420,567	6,235,758	4,556,460	1,962,124	5,504,416
Other countries	8,685,612	2,694,293	802,516	2,845,949	5,520,323	4,705,049	286,142
Total imports	114,293,966	56,676,803	102,991,410	70,659,352	156,543,820	197,214,760	141,813,127

Lead imported into the United States, by classes, 1913–1919, in pounds.

[General imports.]

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.
		Gross weight.	Lead content.		
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966
1914	23,649,637	33,444,503	32,730,320	296,846	56,676,803
1915	18,185,140	86,247,995	83,986,988	819,282	102,991,410
1916	35,086,100	24,943,660	24,262,435	11,310,817	70,659,352
1917	41,292,876	109,279,997	103,664,970	11,585,974	156,543,820
1918	37,070,340	155,810,003	149,663,889	10,480,531	197,214,760
1919	19,573,856	115,317,160	112,024,518	10,214,753	141,813,127

Lead imported and entered for consumption in the United States, 1913–1919, by classes.

Year.	Lead in ore.		Base bullion.		Pigs, bars, and old.		Sheets, pipe, and shot.		Not otherwise specified (value).	Total value.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.		
1913	2,306,972	$75,835	17,665,227	$388,116	4,621,270	$105,738	39,171	$3,291	$12,710	$585,690
1914	5,459,961	188,749	8,904,649	301,195	575,290	12,281	62,552	2,753	81,894	586,872
1915	2,865,792	96,010	15,496,230	519,355	997,368	32,951	201,510	17,059	107,580	772,955
1916	10,125,983	368,824	5,242,171	208,277	6,388,097	331,235	532	63	106,560	1,014,959
1917	5,438,931	207,370	6,965,849	470,539	1,756,223	85,743	12,538	2,699	10,287	776,638
1918	6,064,902	344,080	3,559,071	180,070	1,139,950	56,694	6,892	624	36,723	618,191
1919	4,106,823	196,363	31,796,693	1,130,937	10,174,115	415,094	8,018	628	17,187	1,760,209

EXPORTS.

Lead exported from the United States, 1914–1919, by classes.

Year.	Pigs and bars.				Foreign lead used in articles exported with benefit of drawback.[a]		Manufactures of lead from both domestic and foreign ores.
	From domestic ore.		From foreign ore.				
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Value.
1914	117,443,900	$4,501,674	43,090,375	$1,536,797	18,977,352	$733,000	$1,020,476
1915	176,612,208	7,928,518	77,236,303	2,738,263	7,966,372	353,235	2,174,946
1916	200,999,835	13,494,065	19,760,086	1,111,653	10,341,075	689,043	2,522,957
1917	107,376,638	9,560,598	75,304,480	6,650,157	15,074,947	1,296,445	2,288,205
1918	83,662,322	5,889,381	118,832,344	8,309,798	6,852,173	350,851	1,828,473
1919	21,019,605	1,471,256	81,951,396	4,536,273	3,872,130	207,087	2,155,436

[a] Exclusive of lead that entered as pig and was exported in the same form, which would be duplicated in exports of lead from foreign ore.

Pig lead exported from the United States, 1917–1919, by destination, in short tons.

Destination.	1917		1918		1919	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	24,103	10,189	5,590	10,230	657	1,418
Great Britain	13,330	13,461	26,185	40,412	3,039	20,174
Netherlands	140	168	.....	.....	246	616
France	791	995	11	862	2,208	1,120
Italy	731	1,210	1,462	112	.....	.....
Russia	7,366	7,790	299	115	5	.....
Japan	937	280	4,381	4,319	392	11,452
Other countries	6,290	3,559	3,903	3,366	3,963	6,196
	53,688	37,652	41,831	59,416	10,510	40,976

PRICES.

[See statement on p. 12A.]

LIME.

PRODUCTION.

Lime burned and sold in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.[a]	Average price per ton.	Number of plants in operation.
1910	3,505,954	$14,088,039	$4.02	1,125
1911	3,392,915	13,689,054	4.03	1,139
1912	3,529,462	13,970,114	3.96	1,017
1913	3,595,390	14,648,362	4.07	1,023
1914	3,380,928	13,268,938	3.92	954
1915	3,622,810	14,424,036	3.98	906
1916	4,073,433	18,509,305	4.54	778
1917	3,786,364	23,807,877	6.29	595
1918	3,206,016	26,808,909	8.36	496
1919	3,330,347	29,448,553	8.84	539

[a] The value given represents the value of bulk lime f. o. b. at point of shipment and does not include cost of barrel or package.

Lime sold in the United States in 1918 and 1919, by uses.

Use.	Percentage of total quantity.	Quantity (short tons).	Value.	Average price per ton.
1918.				
Building lime	28.5	914,186	$7,781,388	$8.51
Chemical works	17.7	566,532	4,177,302	7.37
Paper mills	10.1	325,172	2,610,645	8.03
Glassworks	1.1	34,051	265,855	7.81
Sugar factories	1.1	36,494	314,748	8.62
Tanneries	2.3	74,350	637,960	8.58
Agriculture	12.2	391,047	2,698,848	6.90
Metallurgy	7.9	253,778	1,884,672	7.43
Dealers—uses not specified	3.5	111,343	960,596	8.63
Other uses [a]	15.6	499,063	5,476,895	10.97
	100.0	3,206,016	26,808,909	8.36
Hydrated lime (included in above total)	.....	620,216	5,342,113	8.61
1919.				
Building lime	35.8	1,191,434	11,484,318	9.64
Chemical works	14.2	472,718	3,848,778	8.14
Paper mills	10.1	335,813	2,836,347	8.45
Glassworks	1.3	44,618	336,020	7.53
Sugar factories	.4	13,111	163,526	12.47
Tanneries	1.8	59,978	580,022	9.67
Agriculture	13.2	438,632	3,345,039	7.63
Metallurgy	8.9	295,622	2,152,554	7.28
Dealers—uses not specified	2.7	90,117	954,909	10.60
Other uses [a]	11.6	388,304	3,747,040	9.65
	100.0	3,330,347	29,448,553	8.84
Percentage of increase in 1919	.....	3.9	9.8	5.7
Hydrated lime (included in above total)	.....	777,408	7,061,146	9.08
Percentage of increase of hydrated lime in 1919	.....	25.3	32.2	5.5

[a] Includes lime for sand-lime brick, slag cement, alkali works, sheep dipping, disinfectant, manufacture of soap, cyanide plants, glue factories, purification of water, etc.

Hydrated lime manufactured and sold in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Average price per ton.	Number of plants reporting operations.
1910	320,819	$1,288,789	$4.02	51
1911	304,593	1,372,057	4.50	60
1912	416,890	1,829,064	4.39	64
1913	493,269	2,205,657	4.47	80
1914	515,121	2,239,916	4.35	82
1915	581,114	2,457,602	4.23	84
1916	717,382	3,626,998	5.06	89
1917	709,157	4,643,004	6.55	90
1918	620,216	5,342,113	8.61	90
1919	777,408	7,061,146	9.08	93

Hydrated lime sold in the United States, 1918 and 1919, by uses.

Use.	1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Building	312,599	$2,800,077	455,811	$4,086,089
Chemical	31,107	282,501	24,219	217,177
Paper mills	10,756	101,523	6,000	61,120
Sugar factories	7,471	61,807	5,331	48,541
Tanneries	13,557	122,317	15,268	146,447
Glassworks	922	8,509	2,002	19,398
Agriculture	181,890	1,452,436	198,165	1,784,110
Dealers	32,555	249,590	27,426	258,537
Other	29,359	263,353	43,186	439,727
	620,216	5,342,113	777,408	7,061,146

IMPORTS.

Lime imported and entered for consumption in the United States, 1910–1919.[a]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	6,498	$63,791	1915	1,956	$22,489
1911	5,232	55,255	1916	7,959	71,663
1912	4,268	48,153	1917	7,353	70,505
1913	4,139	48,538	1918	6,650	73,458
1914	3,455	33,670	1919	8,679	128,519

[a] Most of the lime imported into the United States comes from Canada.

EXPORTS.

Lime exported from the United States, 1913–1919.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1913	29,475	$212,345	$7.20	1917	18,794	$168,671	$8.97
1914	24,141	170,744	7.07	1918	7,191	105,803	14.71
1915	16,223	106,312	6.55	1919	6,372	108,370	17.01
1916	23,973	132,769	5.54				

LITHIUM MINERALS.

PRODUCTION.

Lithium minerals produced in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	238	$2,380	1915	486	$9,867
1911	500	9,000	1916	619	12,035
1912	360	6,800	1917	2,062	42,912
1913	530	14,900	1918	5,894	111,600
1914	525	8,000	1919	6,287	115,000

IMPORTS AND EXPORTS.

Imports and exports of lithium minerals are not reported separately.

LITHOGRAPHIC STONE.

PRODUCTION.

During 1913 and 1914 small quantities of lithographic stone were quarried at Brandenburg, Meade County, Ky. No domestic production was reported for 1915. Statistics of production are available since 1916 only.

Lithographic stone produced in the United States, 1916–1919.

Year.	Quantity (pounds).	Value.
1916	40,000	$1,500
1917	5,832	489
1918	6,000	350
1919	.....	.....

IMPORTS.

Value of lithographic stone imported for consumption in the United States, 1910–1919.

Year.	Value.	Year.	Value.
1910	$97,502	1915	$8,870
1911	106,232	1916	749
1912	88,994	1917	.....
1913	70,984	1918	.....
1914	46,043	1919	[a] 216,293

[a] Represents 464,914 pounds of stone which was brought into the United States from the following sources: Germany ($203,882), Netherlands ($12,058), England ($182), Italy ($156), and Canada ($15).

EXPORTS.

No exports of lithographic stone are reported.

MAGNESITE.

PRODUCTION.

Crude domestic magnesite sold or treated in the United States, 1913–1919.

Year.	California.		Washington.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	9,632	$77,056	.....	.....	9,632	$77,056
1914	11,293	124,223	.....	.....	11,293	124,223
1915	30,499	274,491	.....	.....	30,499	274,491
1916	154,259	1,388,331	715	$5,362	154,974	1,393,693
1917	211,663	2,116,630	105,175	783,188	316,838	2,899,818
1918	84,077	761,811	147,528	1,050,790	231,605	1,812,601
1919	50,020	504,973	106,206	743,442	156,226	1,248,415

World's production of magnesite (estimated), 1913 and 1917, in metric tons.

Country.	1913	1917
Australia	220	8,500
Austria-Hungary	[a] 400,000	(b)
Canada	1,600	[c] 58,000
Greece	96,600	145,000
India	16,000	17,640
Italy	600	.....
Spain	900	1,500
Transvaal	600	780
Turkey	8,000	(b)
United States	8,740	287,400
Mexico, Norway, Russia	5,000	5,000
	538,260	523,820

[a] Exports. [b] No figures available. [c] Production in 1918.

IMPORTS.

Imports are principally from Austria, Greece, and Canada.

Magnesite imported for consumption in the United States, 1917–1919.

	1917		1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Magnesite:						
Calcined, not purified	3,966	$232,601	19,049	$824,022	9,471	$270,721
Crude	30,277	232,105	5,432	103,233	6,381	103,311

EXPORTS.

Exports are negligible and are not recorded.

MAGNESIUM.

PRODUCTION.

Metallic magnesium produced in the United States, 1915–1919.

Year.	Number of producers.	Quantity (pounds).	Value.	Average price per pound.	
				Stick.	Powder.
1915	3	87,500	$440,000	$5.00	.....
1916	4	75,400	311,462	4.13	.....
1917	5	115,813	233,626	2.02	.....
1918	4	284,118	615,217	1.81	$2.67
1919	3	127,465	247,302	1.83	2.85

IMPORTS.

During 1919, 13,239 pounds of magnesium, valued at $13,583, was imported, and during the last six months of 1918 the imports were 11,899 pounds, valued at $16,259. Prior to 1915 the entire domestic supply was imported, but such imports are not separately shown until July, 1918.

EXPORTS.

During 1917 and 1918 thousands of pounds of magnesium was exported and sold to Great Britain, France, and Italy, but no separate record of exports of magnesium is kept.

MANGANESE.

SUPPLY.

Manganese alloys and ore produced in the United States and imported from important foreign sources, 1913–1919, in long tons.

Year.	Steel.	Ferromanganese.		Spiegeleisen.		Manganese ore.				
	Production.[a]	Shipments.	Imports.	Shipments.	Imports.	Shipments.	Total imports.	Imports from—		
								Russia.	India.	Brazil.
1913	31,300,874	119,495	128,070	106,980	77	4,048	345,090	124,337	141,587	70,200
1914	23,513,030	100,731	82,997	76,625	2,870	2,635	283,294	52,681	103,583	113,924
1915	32,151,036	144,260	55,263	114,556	200	9,613	320,778	.....	36,450	275,579
1916	42,773,680	224,103	90,928	182,837	.....	31,474	576,321	.....	51,960	471,837
1917	45,060,607	260,225	41,969	189,241	3,968	129,405	629,972	.....	48,975	512,517
1918	44,462,432	306,076	27,168	263,861	1,969	305,869	491,303	.....	29,275	345,877
1919	34,671,232	198,255	33,022	90,855	27	55,322	333,344	6,916	9,200	246,592

[a] According to American Iron and Steel Institute.

PRODUCTION.

Manganese and manganiferous ore shipped from mines in the United States, 1913–1919.

Year.	Ore containing 35 per cent of manganese or more.		Ore containing 10 to 35 per cent of manganese.		Ore containing 5 to 10 per cent of manganese.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	4,048	$40,480	51,512	[a] $25,124	7,891	(a)
1914	2,635	27,377	91,666	[a] 218,497	6,599	(a)
1915	9,613	113,111	180,953	796,981	14,782	$20,173
1916	31,474	656,278	453,853	1,787,429	90,473	189,201
1917	129,405	4,109,722	730,759	3,036,292	130,185	369,769
1918	305,869	8,240,386	916,163	4,603,790	254,299	1,031,789
1919	55,322	1,796,863	309,834	1,182,528	123,899	369,964

[a] Value of ore containing 5 to 10 per cent manganese included in figures for ore containing 10 to 35 per cent. Figures not separable.

Manganiferous silver ore shipped from mines in the United States, 1913–1919, in long tons.

Year.	Arizona.	Colorado.	Nevada.	New Mexico.	Utah.
1913	.....	49,753	.....	.....	.....
1914	.....	39,881	.....	.....	.....
1915	1,452	30,921	104,498	.....	55
1916	7,392	106,863	122,429	.....	27
1917	32,009	124,715	122,872	.....	100
1918	10,854	124,041	80,096	475	.....
1919	1,964	40,824	77,815	250	.....

Manganiferous iron ore shipped from the Cuyuna district, Minn., 1913–1919, in long tons.

Year.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.	Year.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.
1913	26,200	.....	1917	359,542	91,590
1914	55,192	.....	1918	625,009	227,202
1915	42,973	.....	1919	138,952	98,220
1916	193,257	45,712			

Manganese ore produced in principal producing countries, 1913 to 1919, in metric tons.

Country.	Percentage of manganese.	1913	1914	1915	1916	1917	1918	1919
North America:								
Canada	.....	.....	25	182	868	143	399	[a] 591
Costa Rica	37–48	.....	.....	.....	[a] 1,263	[a] 7,278	[a] 9,835	[a] 10,148
Cuba	36–44	.....	.....	[a] 5,223	[a] 31,054	[a] 45,225	[a] 84,306	[a] 35,887
Mexico	40+	.....	.....	.....	.....	73	2,878	[b] 114
Panama	50±	.....	.....	.....	[a] 10,666	[a] 5,285	[a] 5,696	[a] 2
Porto Rico	35+	.....	.....	.....	[c] 749	[c] 1,208	[c] 1,372	[d]
United States	35+	4,113	2,677	9,767	31,978	131,482	310,778	56,210
South America:								
Brazil	38–50	122,300	183,630	288,671	503,130	532,855	[a] 351,428	[a] 250,550
Chile	40–48	.....	.....	.....	.....	[a] 205	[a] 3,046	[a] 448
Ecuador	.....	.....	.....	.....	.....	.....	[a] 109	[a] 20
Peru	.....	.....	.....	.....	.....	.....	[a] 20	.....
Europe:								
Austria	.....	16,540	13,808	11,926	[d]	[d]	[d]	[d]
Belgium	.....	.....	.....	500	3,870	2,040	2,610	.....
Bosnia and Herzegovina	.....	5,800	[d]	10,422	22,674	48,851	[d]	[d]
France	30+	7,732	6,393	10,324	10,807	11,589	9,871	4,815
Germany	30+	760	[d]	[d]	[d]	[d]	[d]	[d]
Greece	.....	.....	.....	408	3,600	.....	[d]	[d]
Hungary	.....	19,006	14,413	[d]	[d]	90,269	[d]	[d]
Italy	18–45	1,622	1,649	12,577	18,147	24,532	31,896	30,841
Russia	41–48	1,310,064	[c]715,057	[c] 8,844	[c] 8,862	[d]	[d]	[d]
Spain	29+	21,594	13,155	14,328	14,178	57,474	77,714	66,685
Sweden	.....	4,001	3,643	7,607	8,894	19,873	16,570	12,278
United Kingdom	30+	5,480	3,492	4,714	5,222	10,101	17,736	12,272
Africa:								
Gold Coast	.....	.....	.....	.....	[e]	[e]	30,777	35,754
Tunis	.....	.....	.....	1,460	2,027	5,970	820	1,313
Union of South Africa	.....	.....	.....	.....	.....	112	494	141
Asia:								
China	.....	.....	.....	.....	.....	[a] 20	[a] 3,048	[a] 1
India	47–52	828,128	693,858	457,646	664,704	600,296	526,266	543,582
Japan	50+	18,259	17,067	25,871	49,310	51,374	[f] 29,759	[f] 9,555
Oceania:								
Australia	40+	27	26	556	1,292	290	9,034	5,049

[a] Imports into the United States. Production and exports not available.
[b] Official. Commerce reports give production as 2,294 metric tons, and imports into the United States from Mexico were 6,396 metric tons in 1919.
[c] Exports.
[d] Not available.
[e] Shipments June, 1916, to November, 1917, 31,482 metric tons.
[f] Official figures covering all mines that produced over 375 metric tons. Unofficial figures for all mines were 59,000 metric tons for 1918 but are not yet available for 1919.

MANGANIFEROUS ZINC RESIDUUM.

PRODUCTION.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation three products are obtained from these ores, one containing the greater part of the franklinite and the remaining

two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing about 15 per cent of manganese and 40 per cent of iron, is smelted to spiegeleisen.

No price is given for this material as it is not sold in the open market but is reduced to spiegeleisen by the company that produces it.

Manganiferous residuum produced from zinc roasting in the United States, 1910–1919.

Year.	Quantity (long tons).	Year.	Quantity (long tons).
1910	137,173	1915	159,318
1911	109,296	1916	198,817
1912	104,670	1917	155,332
1913	102,239	1918	146,796
1914	100,198	1919	80,418

MARL.

PRODUCTION.

Calcareous marl produced in the United States, 1916–1919.[a]

Year.	Quantity (short tons).	Value.	Average price per ton.
1916	58,088	$144,768	$2.49
1917	73,900	165,223	2.24
1918	98,694	261,082	2.65
1919	91,437	327,294	3.58
Percentage of increase or decrease in 1919	−7	+25	+35

[a] Figures not available prior to 1916.

IMPORTS AND EXPORTS.

No imports or exports of marl are reported.

MICA.

PRODUCTION.

Domestic mica sold in the United States, 1913–1919.

Year.	Sheet mica.		Scrap mica.		Total quantity (short tons).	Total value.
	Quantity (pounds).	Value.	Quantity (short tons).	Value.		
1913	1,700,677	$353,517	5,322	$82,543	6,172	$436,060
1914	556,933	278,540	3,730	51,416	4,008	329,956
1915	553,821	378,259	3,959	50,510	4,236	428,769
1916	865,863	524,485	4,433	69,906	4,866	594,391
1917	1,276,533	753,874	3,429	52,908	4,067	806,782
1918	1,644,200	731,810	2,292	33,130	3,114	764,940
1919	1,545,709	483,567	3,258	58,084	4,031	541,651

Mica produced by chief producing States, 1914–1919.

State and year.	Sheet mica.			Scrap mica.		Total quantity.	Total value.
	Quantity.		Value.	Quantity.	Value.		
North Carolina:	*Pounds.*	*Short tons.*		*Short tons.*		*Short tons.*	
1914	274,121	137	$171,370	1,789	$23,900	1,926	$195,270
1915	281,074	141	266,650	2,840	33,943	2,981	300,593
1916	546,553	273	380,700	2,755	41,880	3,028	422,580
1917	643,476	322	543,207	2,180	34,134	2,502	577,341
1918	941,200	471	460,450	1,046	12,930	1,517	473,380
1919	1,021,306	511	331,498	1,639	32,338	2,150	363,836
New Hampshire:							
1914	133,556	67	39,588	600	8,249	667	47,837
1915	96,685	48	59,414	516	7,557	564	66,971
1916	125,502	63	64,386	724	10,853	787	75,239
1917	472,519	236	159,822	680	9,229	916	169,051
1918	376,900	188	106,200	530	7,040	718	113,240
1919	235,724	118	90,915	738	13,356	856	104,271
Georgia:							
1914	(a)	(a)	(a)	(a)	(a)	(a)	(a)
1915	4,949	2	635	.....	.....	2	635
1916	16,037	8	2,094	.....	.....	8	2,094
1917	30,534	15	12,141	26	1,400	41	13,541
1918	208,200	104	77,300	40	2,750	144	80,150
1919	47,018	24	19,682	51	778	75	20,460
Virginia:							
1914	27,672	14	22,358	153	2,295	167	24,653
1915	10,808	5	9,590	63	828	68	10,418
1916	39,978	20	18,251	182	2,703	202	20,954
1917	68,558	34	22,831	253	2,709	287	25,540
1918	78,500	39	46,200	404	4,280	443	50,480
1919	(a)	(a)	(a)	578	7,811	(a)	(a)
South Dakota:							
1914	27,323	14	1,366	515	6,138	529	7,504
1915	25,992	13	8,230	179	2,684	192	10,914
1916	115,392	58	49,298	527	10,472	585	59,770
1917	37,523	19	5,975	272	5,033	291	11,008
1918	(a)	(a)	(a)	(a)	(a)	(a)	(a)
1919	.....	.....	.....	(a)	(a)	(a)	(a)
Alabama:							
1914	32,900	16	3,964	.....	.....	16	3,964
1915	8,400	4	5,545	23	395	27	5,940
1916	14,132	7	4,955	65	660	72	5,615
1917	18,476	9	3,528	12	280	21	3,808
1918	11,800	6	3,150	.....	.....	6	3,150
1919	(a)	(a)	(a)	.....	.....	(a)	(a)

[a] Figures may not be published, as there were less than three producers.

World's production of sheet mica, 1913–1918, in short tons.

Year.	United States.	India.	Canada.[a]	All other countries.[b]	Total.	Percentage of total represented by production in United States.
1913	850	2,288	552	[c] 190	3,880	22
1914	278	2,026	298	[c] 21	2,623	11
1915	277	1,357	209	[c] 58	1,901	15
1916	433	2,430	604	[c] 79	3,546	12
1917	638	2,291	583	[c] 218	3,730	17
1918	822	3,062	374	(d)	.....	.....

[a] Estimated as one-half of the total reported production of mica in Canada.
[b] The total reported production of mica for the other countries.
[c] Incomplete, as no figures of production are available for some of the countries.
[d] No figures available.

World's production of scrap mica, 1913–1918, in short tons.

Year.	England.[a]	United States.[b]	Canada.[c]	All other countries.[d]	Total.
1913	36,944	5,747	828	1,239	44,758
1914	(e)	3,869	447	1,022	.....
1915	(e)	4,098	314	707	.....
1916	(e)	4,649	906	1,255	.....
1917	(e)	3,748	875	f 1,200	.....
1918	(e)	2,703	560	(e)	.....

[a] All derived from the clay pits of Cornwall and Devon.
[b] The reported production plus one-half of the sheet.
[c] Three-quarters of the total production reported. One-half of the reported production of mica in Canada is considered as uncut sheet and the other half as scrap. One-half of the sheet probably eventually becomes scrap, giving an estimate for total scrap of three-quarters of the total reported production.
[d] One-half of the reported production of sheet.
[e] No figures available.
[f] Estimated.

Value of world's production of mica, 1913–1918.

Year.	United States.	India.	Canada.	Other countries.	Total.
1913	$436,060	$561,249	$194,304	$133,675	$1,325,288
1914	329,956	428,690	109,061	17,323	885,030
1915	428,769	360,797	91,905	36,327	917,798
1916	594,391	531,638	255,239	62,157	1,443,425
1917	806,782	(a)	358,851	167,908	.....
1918	764,940	(a)	271,550	(a)	.....

[a] No figures available.

IMPORTS.

Mica imported for consumption in the United States, 1913–1919.

Year.	Sheet.				Ground.		Total.	
	Unmanufactured.		Cut and splittings.					
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1913	2,047,571	$751,092	(a)	$191,926	290,757	$4,765	(a)	$947,783
1914	360,888	168,591	(a)	456,805	404,848	4,088	(a)	629,484
1915	433,822	240,449	(a)	447,962	344,040	3,858	(a)	692,269
1916	703,832	421,856	(a)	646,080	362,000	3,420	(a)	1,071,356
1917	656,391	414,823	(a)	1,014,181	92,963	1,044	(a)	1,430,048
1918	741,429	658,576	(a)	880,906	11,587	1,647	(a)	1,541,129
1919	723,713	726,532	(a)	762,228	62	9	(a)	1,488,769

[a] Quantity not reported.

EXPORTS.

Mica exported from the United States, 1913–1919.

Year.	Unmanufactured.		Manufactured.	Total value.
	Quantity (pounds).	Value.	Value.	
1913	298,711	$14,175	$48,009	$62,184
1914	467,451	23,145	27,751	50,896
1915	54,183	5,118	33,915	39,033
1916	63,168	4,544	74,127	78,671
1917	a11,771	3,073	71,412	74,485
1918	(b)	(b)	(b)	74,529
1919	(b)	(b)	(b)	109,348

[a] For six months, January to June.
[b] Unmanufactured and manufactured not separately stated.

MILLSTONES.

[See under Abrasive materials.]

MINERAL PAINTS.

PRODUCTION.

Domestic natural mineral pigments [a] sold in the United States, 1909–1916.[b]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1909	60,220	$567,028	1913	70,595	$512,410
1910	68,623	527,795	1914	66,766	633,390
1911	62,739	498,821	1915	57,442	551,598
1912	74,657	561,693	1916	(b)	(b)

[a] Include ocher, umber, sienna, metallic paint, mortar colors, and ground slate and shale.
[b] Canvass discontinued after 1915.

Domestic zinc and lead pigments,[a] made directly from ores, sold in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	75,162	$6,852,804	1915	141,383	$14,962,461
1911	80,611	7,343,762	1916	135,606	23,515,803
1912	106,497	9,507,895	1917	140,636	26,972,137
1913	97,573	9,020,896	1918	135,746	26,464,590
1914	106,791	9,978,710	1919	155,648	25,810,671

[a] Include sublimed blue lead, sublimed white lead, leaded zinc oxide, and zinc oxide.

MINERAL WATERS.

PRODUCTION.

Domestic mineral waters sold in the United States, 1913–1919.

Year.	Commercial springs.	Quantity sold (gallons).	Value.	Average price per gallon (cents).
1913	838	57,867,399	$5,631,391	10
1914	829	54,358,466	4,892,328	9
1915	812	52,113,503	5,138,794	10
1916	802	55,928,461	5,735,035	10
1917	717	46,784,419	4,931,710	11
1918	569	40,709,722	4,533,001	11
1919	527	38,697 280	4,880,186	13

IMPORTS.

Mineral waters imported for consumption in the United States, 1913–1919.

Year.	Quantity (gallons).	Value.	Price per gallon (cents).	Year.	Quantity (gallons).	Value.	Price per gallon (cents).
1913	3,364,676	$955,788	28	1917	618,405	$268,665	43
1914	2,786,142	857,707	31	1918	489,487	241,641	49
1915	1,528,181	551,648	36	1919	203,014	116,948	58
1916	1,553,199	624,302	40				

EXPORTS.

Large quantities of a few domestic waters are exported, but no statistics regarding such shipments are available. The quantity and the value of these waters are included in the statistics of production for the United States.

MOLYBDENUM.

PRODUCTION.

The production of molybdenum ore in 1919 amounted to about 83,700 tons, from which was obtained 971 tons of concentrates carrying 198.6 tons of molybdenum, of which concentrates carrying 149 tons of molybdenum were sold, and 108.7 tons carrying 49.6 tons of molybdenum were on hand at the end of the year.

Molybdenum in ore and concentrates produced and sold in the United States, 1914–1919.

Year.	Quantity sold (pounds).	Value.	Year.	Quantity sold (pounds).	Value.
1914	1,297	$1,297	1917	350,200	$495,350
1915	181,769	114,866	1918	861,637	1,253,700
1916	206,740	205,000	1919	297,926	341,814

World's output of molybdenum concentrates in terms of the contained molybdenum, 1915–1918.

[M=molybdenite; W=wulfenite.]

Country.	Ore mineral.	1915		1916		1917		1918	
		Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
Australia	M	71.9	$377,700	70.39	$314,800	102.05	$456,273	111.8	$500,000
Austria	W	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Bolivia	M	6.5	5,475	5.17	7,663	(a)	(a)	(a)	(a)
Canada	M	.....	.....	42.5	156,461	78.5	288,705	102.8	434,528
Chile	M	.....	.....	.8	.....	20.1	9,836	.....	.....
China	M	(a)	(a)	2.7	1,700	2.4	1,600	1.08	3,689
Chosen	M	.....	.....	3.2	12,463	59.2	19,034	10.7	25,884
Germany	M	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
India	M	.....	.....	.4	983	.7	3,050	.09	551
Italy	M	.....	.....	.....	.....	.2	(a)	.....	.....
Japan	M	.....	.....	18.3	31,177	12.06	30,124	b 70.3	12,746
Norway	M	72.3	(a)	73.1	(a)	82.1	533,333	84.9	1,248,804
Peru	M	1.3	6,990	3.08	14,120	3.8	20,970	1.3	7,445
Spain	W	1.8	1,861	.....	.....	.....	.....	.....	.....
Sweden	M	2.2	4,644	.3	1,194	20.3	40,000	25.1	463,629
United States	M, W	82.4	114,866	93.8	205,000	158.8	495,350	390.8	1,253,700

a Figures not available.

b 54.7 metric tons coarse ore of low grade.

IMPORTS.

During 1919, 106,743 pounds of molybdenum ore, valued at $77,572, was imported into the United States. No record of imports of molybdenum ores was kept by the Bureau of Foreign and Domestic Commerce before July 1, 1918. During the last six months of 1918, 140,222 pounds of ore, valued at $123,924, was imported. It is known that in the first half of the year 25,000 pounds of molybdenite, averaging about 75 per cent of MoS_2, was imported from Chosen and 19,000 pounds from some undesignated part of Asia. For imports of ferromolybdenum see under ferroalloys.

EXPORTS.

Exports of ferromolybdenum are not separately classified.

NATURAL GAS.

[See Gas (natural).]

NICKEL.

PRODUCTION.

Prior to 1919 the United States produced no nickel from domestic materials except as a by-product of copper refining, as shown in the following table. In 1919, however, nickel was also produced from cobalt ores mined on the property of the Missouri Cobalt Co. near Fredericktown, Mo. Large quantities of matte imported from Canada and smaller quantities of matte from New Caledonian ore are, however, refined in the United States:

Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1911–1919, and from cobalt ores in 1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1911	445	$127,000	1916	918	$671,192
1912	328	93,600	1917	402	331,556
1913	241	79,393	1918	441	401,000
1914	423	313,000	1919[a]	511	434,485
1915	822	538,222			

[a] Including nickel produced from cobalt ores mined in Missouri.

IMPORTS.

Nickel imported for consumption in the United States, 1913–1919.

Year.	Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc.		Value of manufactured articles of nickel and nickel sheets and strips.	Total value.
	Quantity (pounds).	Value.		
1913	47,446,520	$6,562,555	$38,200	$6,600,755
1914	35,098,958	5,000,594	28,224	5,028,818
1915	56,599,381	7,629,686	6,458	7,636,144
1916	72,649,377	9,899,340	25,880	9,925,220
1917	75,526,767	9,617,163	45,248	9,662,411
1918	73,207,147	11,520,775	115,243	11,636,018
1919	36,562,388	8,334,135	90,451	8,424,586

Nickel imported for consumption in the United States, 1918 and 1919, by forms.

Form.	1918		1919	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Nickel ore and matte (nickel content)	[a] 34,875,878	[a] $4,576,981	(b)	(b)
Nickel ore (nickel content)	(c)	(c)	10,431,602	$1,959,729
Nickel matte (nickel content)	[d] 38,317,327	[d] 6,940,565	18,871,626	3,820,651
Nickel, alloys, pig, bars, etc	40	8	7,258,082	2,553,431
Nickel oxide	13,902	3,221	1,078	324
Nickel sheets and strips	(e)	[e] 2,731	10,152	4,889
	[f] 8,612	[f] 4,150		
All other manufactures	(e)	[e] 84,138	87,527	85,562
	[f] 10,495	[f] 24,224		
	73,226,254	11,636,018	36,660,067	8,424,586

[a] Figures cover six months, January to June. Separately classified beginning with July.
[b] Separately classified during 1919.
[c] Included under "Nickel ore and matte" for first six months. No ore imported July to December.
[d] Figures cover six months, July to December. Included under "Nickel ore and matte" prior to July.
[e] Quantity not shown. Value covers six months, January to June.
[f] Figures cover six months, July to December.

Nickel ore and matte imported into the United States, 1918 and 1919, by countries.

Country.	1918					1919				
	Nickel ore and matte.			Manufactures.[a]		Nickel ore and matte.			Manufactures.	
	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (pounds).	Value.	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (pounds).	Value.
Australia	2,339	2,027,850	$433,878			3,008	3,716,293	$760,887		
Canada	63,835	70,645,034	10,974,325	9,518	$4,441	22,760	25,503,767	4,997,650	7,303,679	$2,580,695
Chile	1	91	44							
China									3	2
Denmark									4	17
England				9,328	5,517				23,607	16,246
France				86	411				1,188	5,055
Germany									68	271
Japan				4,870	6,671				23,777	13,167
Netherlands									11	172
Oceania:										
British (other than Australia)	489	409,023	85,934							
French	112	111,207	23,365			56	83,168	21,843		
Spain									10	10
Switzerland				1,172	12,339				3,414	28,247
	66,776	73,193,205	11,517,546	24,974	29,379	25,824	29,303,228	5,780,380	7,355,761	2,643,882

[a] Figures cover six months, July to December. Not separately classified by countries prior to July.

EXPORTS.

Nickel, nickel oxide, and matte exported from the United States, 1910–1919.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1910	15,244,937	$4,704,088	1915	26,418,550	$10,128,514
1911	25,099,586	8,283,777	1916	33,404,011	12,952,493
1912	25,815,016	8,515,332	1917	21,992,820	8,936,620
1913	29,173,088	9,686,794	1918	17,469,500	6,927,041
1914	27,595,152	9,455,528	1919	3,810,656	1,697,544

OILSTONES AND SCYTHESTONES.

[See under Abrasive materials.]

PEAT.

PRODUCTION.

Crude air-dried peat used in the United States, 1913–1919.

Year.	Fertilizer and fertilizer ingredient.		Stock food.		Fuel.		Other products.[a]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	28,460	$169,600	4,800	$27,600	.....	.....	.....	.....	33,260	$197,200
1914	37,729	249,899	(b)	(b)	1,925	$6,540	7,439	$53,253	b 47,093	b 309,692
1915	38,304	258,447	3,980	30,090	.....	.....	.....	.....	42,284	288,537
1916	48,106	336,004	4,300	32,250	(c)	(c)	100	850	52,506	369,104
1917	92,263	658,500	5,100	51,400	.....	.....	.....	.....	97,363	709,900
1918	79,573	775,313	7,096	106,935	20,567	164,745	25	250	107,261	1,047,243
1919	54,690	557,240	6,402	98,940	(c)	(c)	8,105	49,352	69,197	705,532

[a] Peat moss, paper stock, and packing material. Also peat fuel in 1916 and 1919.
[b] Figures for stock food not available.
[c] Included under "Other products."

IMPORTS.

Peat moss imported for consumption in the United States, 1913–1919.

Year.	Quantity (short tons).	Value.	Average price per ton.	Year.	Quantity (short tons).	Value.	Average price per ton.
1913	10,983	$55,719	$5.07	1917	506	$4,966	$9.81
1914	9,921	57,542	5.80	1918	.....	.....	.....
1915	7,514	48,142	6.41	1919	464	16,345	35.23
1916	3,042	27,859	9.16				

EXPORTS.

No exports of peat are reported.

PETROLEUM.

PRODUCTION.

Petroleum produced in the United States, 1859–1919, by fields, in barrels of 42 gallons.

Year.	Appalachian.	California.	Lima-Indiana.	Rocky Mountain.	Illinois.
Prior to 1913	1,075,612,494	543,709,707	423,623,794	12,235,618	186,512,968
1913	25,921,785	97,788,525	4,773,138	2,595,321	23,893,899
1914	24,101,048	99,775,327	5,062,543	3,783,148	21,919,749
1915	22,860,048	86,591,535	4,269,591	4,454,000	19,041,695
1916	23,009,455	90,951,936	3,905,003	6,476,289	17,714,235
1917	24,932,205	93,877,549	3,670,293	9,199,310	15,776,860
1918	25,401,466	97,531,997	3,220,722	12,808,896	13,365,974
1919	31,830,000	101,183,000	3,486,000	13,383,000	11,960,000
Grand total since production began	1,253,668,000	1,211,410,000	452,011,000	64,936,000	310,185,000

Year.	Mid-Continent.	Gulf.	Other.[a]	United States.
Prior to 1913	385,595,568	193,904,149	54,077	2,821,248,375
1913	84,920,225	8,542,494	10,843	248,446,230
1914	97,994,900	13,118,028	7,792	265,762,535
1915	123,294,317	20,578,653	14,265	281,104,104
1916	136,934,439	21,768,096	7,705	300,767,158
1917	163,506,205	24,342,879	10,300	335,315,601
1918	179,383,098	24,207,620	7,943	355,927,716
1919	193,147,000	23,366,000	12,000	378,367,000
Grand total since production began	1,364,776,000	329,828,000	125,000	4,986,939,000

[a] Alaska, Michigan, Missouri, and New Mexico.

Petroleum produced in the United States, 1918 and 1919, by States and fields.

State and district.	1918			1919	
	Quantity (barrels).	Value.	Average price per barrel.	Quantity (barrels).	Value.
Alaska	(a)	(a)	(a)	(a)	(a)
California	97,531,997	$118,770,790	$1.218	101,183,000	$142,611,000
Colorado	143,286	188,472	1.315	121,000	183,000
Illinois	13,365,974	31,230,000	2.337	11,960,000	29,720,000
Indiana	877,558	2,028,129	2.311	972,000	2,284,000
Kansas	45,451,017	100,546,202	2.212	33,048,000	77,026,000
Kentucky	4,367,968	11,287,162	2.584	9,278,000	24,597,000
Louisiana	16,042,600	27,535,060	1.716	17,188,000	26,803,000
Michigan	(a)	(a)	(a)	(a)	(a)
Missouri				(a)	(a)
Montana	69,323	125,828	1.815	90,000	171,000
New Mexico				(a)	(a)
New York	808,843	3,307,814	4.089	851,000	3,100,000
Ohio	7,285,005	23,465,197	3.221	7,736,000	23,333,000
Oklahoma	103,347,070	231,136,205	2.237	86,911,000	184,100,000
Pennsylvania	7,407,812	29,606,079	3.997	8,137,000	33,688,000
Tennessee	8,374	21,704	2.592	15,000	37,000
Texas	38,750,031	74,867,537	1.932	79,366,000	157,729,000
West Virginia	7,866,628	31,652,018	4.024	8,327,000	34,890,000
Wyoming	12,596,287	18,159,778	1.442	13,172,000	19,544,000
Undistributed [b]	7,943	15,986	2.013	12,000	50,000
	355,927,716	703,943,961	1.978	378,367,000	759,866,000
SUMMARY.					
Appalachian field	25,401,466	93,917,171	3.697	31,830,000	113,476,000
Lima-Indiana field	3,220,722	7,450,932	2.313	3,486,000	8,453,000
Illinois field	13,365,974	31,230,000	2.337	11,960,000	29,720,000
Mid-Continent field	179,383,098	393,031,158	2.191	193,147,000	417,701,000
Gulf field	24,207,620	41,053,846	1.696	23,366,000	27,957,000
Rocky Mountain field	12,808,896	18,474,078	1.442	13,383,000	19,898,000
California field	97,531,997	118,770,790	1.218	101,183,000	142,611,000
Undistributed [b]	7,943	15,986	2.013	12,000	50,000
	355,927,716	703,943,961	1.978	378,367,000	759,866,000

[a] Included under "Undistributed."
[b] 1918: Alaska and Michigan; 1919: Alaska, Michigan, Missouri, and New Mexico.

World's production of petroleum in 1918 and since 1857, by countries.

[Figures rounded.]

Country.	Production, 1918.			Total production, 1857–1918.		
	Barrels of 42 gallons.	Equivalent in metric tons.	Percentage of total (based on tons).	Barrels of 42 gallons.	Equivalent in metric tons.	Percentage of total (based on tons).
United States	355,928,000	47,457,000	67.82	4,608,572,000	614,476,000	61.11
Mexico	63,828,000	9,506,000	13.58	285,182,000	42,565,000	4.23
Russia	40,456,000	5,520,000	7.89	1,873,999,000	247,983,000	24.66
Dutch East Indies	[a] 13,285,000	[a] 1,837,000	[a] 2.63	188,389,000	25,465,000	2.53
Rumania	8,730,000	1,214,000	1.74	151,408,000	21,058,000	2.10
India	[b] 8,000,000	[b] 1,067,000	1.52	106,162,000	14,155,000	1.41
Persia	[b] 7,200,000	[b] 1,000,000	1.43	14,056,000	1,952,000	.20
Galicia	5,592,000	778,000	1.11	154,051,000	21,424,000	2.13
Peru	[c] 2,536,000	[c] 338,000	.48	24,415,000	3,255,000	.32
Japan and Formosa	2,449,000	326,000	.47	38,498,000	5,133,000	.51
Trinidad	2,082,000	290,000	.41	7,432,000	1,034,000	.10
Egypt	2,080,000	277,000	.40	4,849,000	647,000	.07
Argentina	1,321,000	193,000	.28	4,296,000	617,000	.06
Germany	[b] 711,000	[b] 100,000	.14	16,664,000	2,255,000	.23
Canada	305,000	41,000	.06	24,426,000	3,257,000	.32
Venezuela	190,000	26,000	.04	318,000	44,000	.02
Italy	[b] 36,000	[b] 5,000		974,000	139,000	
Cuba				19,000	3,000	
Other countries				397,000	55,000	
	514,729,000	69,975,000	100.00	7,504,107,000	1,005,517,000	100.00

[a] Includes British Borneo. [b] Estimated. [c] Estimated in part.

STOCKS.

Stocks of petroleum held by pipe-line and other marketing companies and by producers in the United States Dec. 31, 1917–1918.

[Barrels of 42 gallons.]

Source by fields.	Pipe-line stocks.		Producers' stocks.	
	1917	1918	1917	1918
Appalachian	3,821,416	3,616,363	310,966	394,000
Lima-Indiana	1,906,241	1,028,808	71,018	29,000
Illinois	3,560,222	2,366,752	213,349	152,000
Mid-Continent	99,426,423	79,093,643	8,378,031	1,217,000
Gulf	8,384,814	8,168,402	121,001	78,000
Rocky Mountain	515,341	914,734	294,524	714,000
California	28,427,292	26,538,610	4,316,922	3,751,000
	146,041,749	121,727,312	13,705,811	6,335,000

Stocks of petroleum held by pipe-line and other marketing companies and by producers in the United States Dec. 31, 1919.

[Barrels of 42 gallons.]

Source by fields.	Pipe-line stocks.	Producers' stocks.
Appalachian	3,757,000	525,000
Lima-Indiana	[a] 1,323,000	73,000
Illinois	[a] 4,194,000	154,000
Mid-Continent	76,712,000	1,755,000
Gulf	12,575,000	1,344,000
Rocky Mountain	164,000	617,000
California	29,142,000	3,954,000
	127,867,000	8,422,000

[a] Some Lima-Indiana oil stored in Illinois included in Illinois stocks.

IMPORTS AND EXPORTS.

Crude petroleum imported into and exported from the United States, 1913–1919.

Year.	Imports.[a]		Exports.[b]	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.
1913	17,809,058	$12,947,280	4,630,229	$8,448,294
1914	17,247,483	11,465,466	2,969,894	4,958,838
1915	18,140,110	10,389,012	3,768,168	4,282,827
1916	20,570,075	12,602,811	4,095,902	7,029,923
1917	30,162,583	16,400,017	4,098,124	7,668,312
1918	37,735,641	21,319,464	4,900,691	12,084,250
1919	52,821,567	26,442,881	5,924,320	14,805,546

[a] Imports of crude oil into the United States are chiefly from Mexico, with small quantities from other countries.
[b] Exports of crude petroleum are chiefly to Canada. Exports of refined products are not included nor are shipments of crude petroleum to Alaska, Hawaii, Porto Rico, and the Philippine Islands.

PHOSPHATE ROCK.

PRODUCTION.

Phosphate rock sold in the United States, 1910–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1910	2,654,988	$10,917,000	1915	1,835,667	$5,413,449
1911	3,053,279	11,900,693	1916	1,982,385	5,896,993
1912	2,973,332	11,675,774	1917	2,584,287	7,771,084
1913	3,111,221	11,796,231	1918	2,490,760	8,214,463
1914	2,734,043	9,608,041	1919	2,271,983	11,591,268

Phosphate rock sold in the United States, 1918 and 1919, by States.

State.	1918			1919		
	Quantity (long tons).	Value.	Average value per ton.	Quantity (long tons).	Value.	Average value per ton.
Florida:						
Hard rock	62,052	$377,075	$6.08	285,467	$2,452,563	$8.59
Soft rock	8,331	147,103	17.66	14,498	196,318	13.54
Land pebble	1,996,847	5,565,928	2.79	1,360,235	5,149,048	3.79
	2,067,230	6,090,106	2.95	1,660,200	7,797,929	4.70
South Carolina						
Land rock	37,040	164,650	4.45	60,823	308,968	5.08
Tennessee:						
Brown rock	[a] 374,535	1,917,546	5.12	[a] 475,475	3,123,565	6.57
Blue rock				58,550	290,951	4.97
	[a] 374,535	1,917,546	5.12	[a] 534,025	3,414,516	6.39
Western States [b]	11,955	42,161	3.53	16,935	69,855	4.12
	2,490,760	8,214,463	3.30	2,271,983	11,591,268	5.10

[a] Includes brown rock from Kentucky.
[b] 1918: Idaho and Utah; 1919: Idaho, Utah, and Wyoming.

World's production of phosphate rock, 1914–1919, in metric tons.

Country.	1914	1915	1916	1917	1918	1919
Algeria	[a] 355,140	[a] 225,891	[a] 389,211	[a] 234,825	[a] 198,539	276,040
Angaur Island	[a] 60,000	30,000	30,000			
Belgium	105,330	16,350	77,740	138,300	61,700	
Canada [b]	866	197	184	135	127	22
Christmas Island	95,234	24,119	44,209	89,889		
Dutch West Indies:						
Aruba	86,572	51,000	14,700	3,639		10,058
Curaçao	11,219	32,915				
Egypt	71,945	82,998	125,008	115,732	31,147	29,364
France	270,000	145,000	24,700			
French Guiana						
Japan, including Rasa Island	38,264	57,723	114,389	122,000	191,722	
Makatea Island	72,925	71,724	39,285	114,780		40,000
New Caledonia, Huon Island	3,500	8,400				
New South Wales					305	585
New Zealand				5,131	5,080	
Norway [b]	750	1,901	2,236	1,832		
Ocean and Nauru Islands			70,000			
Russia	15,000					
South Australia	6,197	4,688	5,093	5,183	8,204	6,045
Spain	8,312	9,080	14,111	28,148	43,303	25,035
Tunis	1,395,630	1,170,033	1,041,204	576,600	821,145	
United States	2,777,788	1,865,038	2,014,103	2,625,636	2,530,612	2,308,448
	5,374,672	3,797,057	4,006,173	4,061,830		

[a] Exports. [b] Apatite.

IMPORTS.

Imports of phosphate rock are negligible.

EXPORTS.

Phosphate rock marketed in and exported from the United States, 1913–1919.

Year.	Marketed production (long tons).	Exports (long tons).	Proportion of exports to total sales (per cent).	Year.	Marketed production (long tons).	Exports (long tons).	Proportion of exports to total sales (per cent).
1913	3,111,221	1,366,508	44	1917	2,584,287	166,358	6
1914	2,734,043	964,114	35	1918	2,490,760	143,455	6
1915	1,835,667	253,421	14	1919	2,271,983	378,731	17
1916	1,982,385	243,678	12				

PLATINUM AND ALLIED METALS.

PRODUCTION.

REFINED NEW METALS.

Reports received from refiners of platinum, gold bullion, nickel, and copper indicate that 45,109 troy ounces of refined new metals of the platinum group were recovered in 1919, of which about 11,759 ounces are believed to be of domestic origin.

New platinum and allied metals recovered by refiners in the United States, 1915–1919, in troy ounces.

Year.	Platinum.	Iridium.	Iridosmine-osmiridium.	Palladium.	Rhodium.
1915	6,495	274	355	1,541	
1916	24,518	370	315	2,885	
1917	33,009	210	833	4,779	
1918	54,399	465	539	4,024	326
1919	40,220	401	402	3,807	279

SECONDARY METALS.

Dealers and refiners reported sales in 1919 of 61,516 ounces of secondary platinum metals derived from refining scrap and sweeps. The figures that make up this total probably represent some duplication, as the same metal may be handled as scrap several times in a year.

Secondary platinum and allied metals sold in the United States, 1915–1919, in troy ounces.

Year.	Platinum.	Iridium.	Palladium.
1915	42,149	863	958
1916	45,156	1,535	1,284
1917	59,007	9,832	3,347
1918	40,378	3,410	1,795
1919	54,545	3,504	3,467

WORLD'S PRODUCTION.

Statistics of the world's production of platinum and allied metals are at best estimates, though they are derived from the most reliable information obtainable.

Estimated world's production of crude platinum, 1913–1919, in troy ounces.

Country.	1913	1914	1915	1916	1917	1918	1919
Borneo and Sumatra	200	(a)	b 18	b 9	c 52	(a)	(a)
Canada	50	30	100	60	80	30	30
Colombia	15,000	17,500	18,000	25,000	32,000	35,000	35,000
New South Wales and Tasmania	1,500	1,248	303	222	330	d 1,606	d 1,326
Russia	250,000	241,200	124,000	63,900	50,000	25,000	30,000
United States	483	570	742	750	605	647	824
	267,233	260,548	143,163	89,941	83,067	62,283	67,180

a No basis for estimate.
b India alone.
c Dutch East Indies and India.
d Tasmania alone.

IMPORTS.

Platinum and allied metals imported for consumption in the United States, 1918–1919.

Metal.	1918		1919	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire	54,963	$4,949,855	54,550	$5,229,309
Platinum, manufactured products, vases, retorts, etc.	(a)	8,597	22	b17,213
Iridium	1,126	126,282	5,808	975,174
Osmiridium	427	46,321	1,374	112,403
Osmium			2,339	132,097
Palladium	240	36,853	3,739	250,777
Rhodium			222	30,474
	56,756	5,167,908	68,054	6,747,447

a Quantity not given.
b Includes wire to the value of $11,720 imported under 15 per cent duty, quantity not given, and "all other" to the value of $2,821, quantity not given.

EXPORTS.

Platinum exported from the United States, 1913–1919.

Year.	Domestic.			Foreign.				
	Unmanufactured.		Manufactures.	Unmanufactured.		Manufactures.		
						Ingots, bars, etc.		Vases.
	Quantity (troy ounces).	Value.	Value.	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.	Value.
1913	(a)	(a)	(a)	926	$29,510	265	$10,490	$10,000
1914	(a)	(a)	(a)	.....	.....	143	6,560	107
1915	(a)	(a)	(a)	.....	.....	9	416	.....
1916	1,145	$97,988	$83,864	.....	.....	.....	3	.....
1917	3,445	234,433	65,415	.....	.....	11	1,200	.....
1918	119	13,511	23,562	.....	.....	.....	.....	.....
1919	522	75,066	54,529	.....	.....	.....	.....	.....

a Not separately classified prior to 1916.

POTASH.

PRODUCTION.

Potash produced and sold in the United States, 1918, classified according to sources.

Source.	Number of producers.	Production.				Sales.		
		Crude potash (short tons).	Available content of potash (K_2O).		Value at point of shipment.a	Crude potash (short tons).	Available content of potash (K_2O) (short tons).	Value f. o. b. plant.
			Quantity (short tons).	Percentage of total.				
Mineral:								
Natural brines:								
Nebraska lakes	19	116,662	28,854	53	$14,667,565	57,522	14,011	$5,098,023
Other sources	8	32,390	10,862	20		30,849	10,319	4,184,442
Alunite	4	6,180	2,621	5	1,276,774	6,180	2,621	1,276,774
Dust from cement mills	12	12,652	1,549	3	603,617	11,172	1,366	539,567
Dust from blast furnaces / Silicate rocks	6	3,155	310	.5	152,571	3,155	310	152,571
Organic:								
Kelp	8	14,029	4,804	9	2,296,983	14,029	4,804	2,296,983
Molasses, distillery waste	8	11,792	3,467	6	1,335,516	11,792	3,467	1,335,516
Steffens water from beet-sugar refineries	8	8,795	1,374	2	488,509	3,650	742	267,309
Wood ashes	51	1,100	673	1	557,445	1,063	651	549,745
Wool washings and miscellaneous	4	931	289	.5	138,688	931	289	138,688
	128	207,686	54,803	100.0	21,517,668	140,343	38,580	15,839,618

a Includes estimated value for potash held in storage by producers at close of 1918.

Potash produced and sold in the United States, 1919, classified according to sources.

Source.	Production.				Sales.		
	Number of producers.	Crude potash (short tons).	Available content of potash (K_2O).		Crude potash (short tons).	Available content of potash (K_2O) (short tons).	Value f.o.b. plant.
			Quantity (short tons).	Percentage of total.			
Mineral:							
Natural brines—							
Nebraska lakes	10	36,176	9,072	27.9	95,276	23,908	$5,240,352
Other brines	7	[a] 37,395	[a] 12,518	38.6	25,677	10,584	2,744,963
	17	73,571	21,590	66.5	120,953	34,492	7,985,315
Alunite	7	6,599	2,294	7.1	6,599	2,294	718,506
Dust from cement mills	14	11,665	1,258	3.8	13,115	1,439	311,365
Dust from blast furnaces and silicate rocks	8	2,408	221	.7	2,328	214	48,021
Organic:							
Kelp and miscellaneous industrial waste	4	370	134	.4	370	134	37,274
Molasses distillery waste	6	8,791	2,892	8.9	8,541	2,802	801,533
Steffens waste water from beet-sugar refineries	11	[b] 12,423	[b] 3,601	11.1	13,313	3,847	1,081,053
Wood ashes	35	807	484	1.5	844	506	288,202
	102	116,634	32,474	100.0	166,063	45,728	11,271,269

[a] A considerable quantity lost through accident to plant.
[b] A large part of this material used privately.

IMPORTS.

Potash imported and entered for consumption in the United States, 1913–1919.

Year.	Potash salts used mainly in the fertilizer industry. [a]			Potash salts used mainly in manufacturing industries. [b]			Total.		
	Quantity (short tons).		Value.	Quantity (short tons).		Value.	Quantity (short tons).		Value.
	Gross weight.	Potash (K_2O) content.		Gross weight.	Potash (K_2O) content.		Gross weight.	Potash (K_2O) content.	
1913	1,053,684	255,101	$13,200,413	38,904	15,619	$4,873,452	1,092,588	270,720	$18,073,865
1914	766,796	193,878	10,700,199	31,291	13,211	4,721,412	798,087	207,089	15,421,611
1915	100,256	42,519	3,257,114	16,430	6,348	3,001,234	116,686	48,867	6,258,348
1916	4,273	1,726	453,091	22,369	6,159	6,972,307	26,642	7,885	7,425,398
1917	1,165	504	189,159	24,122	7,596	7,599,247	25,287	8,100	7,788,406
1918	525	261	117,438	23,894	7,696	8,790,398	24,419	7,957	8,907,836
1919	127,416	28,484	4,163,739	33,430	11,135	6,028,077	160,846	39,619	10,191,816

[a] Includes kainite, manure salts, muriate, and sulphate. Considerable quantities of muriate and some sulphate were used in manufacturing industries.
[b] Includes bicarbonate, bichromate, bitartrate, carbonate, caustic, chlorate, chromate, cyanide, ferricyanide, ferrocyanide, iodide, nitrate, permanganate, and Rochelle salt.

EXPORTS.

Domestic potash salts exported from the United States, 1918 and 1919.

Material.	1918			1919		
	Quantity (short tons).		Value.	Quantity (short tons).		Value.
	Gross weight.	Potash (K_2O) content.		Gross weight.	Potash (K_2O) content.	
Potassium chlorate	696	264	$534,491	991	376	$524,193
All other potassium salts	.....	.....	837,679	.....	.....	2,231,351
	.....	.....	1,372,170	.....	.....	2,755,544

PUMICE.

[See under Abrasive materials.]

PYRITES.

PRODUCTION.

Pyrites produced in United States, 1910–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1910	241,612	$977,978	1915	394,124	$1,674,933
1911	301,458	1,164,871	1916	439,132	2,038,002
1912	350,928	1,334,259	1917	482,662	2,593,035
1913	341,338	1,286,084	1918	464,494	2,644,515
1914	336,662	1,283,346	1919	420,647	2,558,172

IMPORTS.

Pyrites containing more than 25 per cent of sulphur imported for consumption in the United States, 1910–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1910	803,551	$2,748,647	1915	964,634	$4,817,977
1911	1,006,310	3,788,803	1916	1,244,662	6,728,318
1912	970,785	3,841,683	1917	967,340	5,981,457
1913	850,592	3,611,137	1918	496,792	2,741,676
1914	1,026,617	4,797,326	1919	388,973	2,176,565

EXPORTS.

No exports of pyrites are reported.

QUICKSILVER.

SUPPLY.

Supplies of quicksilver in the United States, 1913–1919.

[Flasks of 75 pounds.]

Year.	Production.		Imports for consumption.		Exports.		Apparent consumption.[a]	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
1913	20,213	$813,171	2,289	$75,361	1,140	$43,574	21,362	$844,958
1914	16,548	811,680	8,198	271,984	1,446	70,753	23,300	1,012,911
1915	21,033	1,804,631	5,625	282,752	3,372	225,509	23,286	1,861,874
1916	29,932	3,768,139	5,659	515,919	8,880	670,475	26,711	3,613,583
1917	36,159	3,808,266	5,207	448,032	10,778	998,470	30,588	3,257,828
1918	32,883	3,863,752	6,719	533,622	3,098	338,620	36,504	4,058,754
1919	21,415	1,933,560	10,635	791,226	9,107	817,328	22,943	1,907,458

[a] Production plus imports minus exports.

PRODUCTION.

Quicksilver produced in the United States, 1917–1919, by States.

[Flasks of 75 pounds.]

State.	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona	40	$4,213	.....	.....	.....	.....
Oregon	388	40,864	702	$82,485	435	$39,276
Texas	10,791	1,136,508	8,451	992,992	5,019	453,166
California	23,938	2,521,151	22,664	2,663,020	15,205	1,372,859
Nevada	997	105,004	1,044	122,670	756	68,259
Idaho	5	526	22	2,585	.....	.....
	36,159	3,808,266	32,883	3,863,752	21,415	1,933,560

World's production of quicksilver, 1910–1918, in flasks of 75 pounds.

[1 metric ton=29.395 flasks.]

Country.	1910	1911	1912	1913	1914	1915	1916	1917	1918
United States	20,601	21,256	25,064	20,213	16,548	21,033	29,932	36,159	32,883
Austria	[a] 17,725	[a] 20,694	[a] 22,428	[a] 24,104	[b] 25,000	[b] 25,000	[b] 25,000	[b] 25,000	[c] 17,637
Hungary	[d] 2,641	[d] 2,339	[d] 2,494	[d] 2,606	[b] 2,500	[b] 2,500	[b] 2,500	[b] 2,500	[b] 2,000
Italy	[e] 26,264	[e] 28,072	[e] 29,406	[e] 29,513	[e] 31,541	[e] 28,954	[f] 32,129	[e] 31,494	[c] 30,512
Russia	[g] 118	.....	.....	.....	.....	[h] 800	[h] 1,100	[b] 500	.....
Spain [i]	32,892	43,912	36,921	36,619	28,000	35,925	23,369	25,147	16,677
Mexico and other countries [b]	4,500	4,500	4,500	4,000	4,000	4,000	4,000	4,000	5,500
	104,741	120,773	120,813	117,055	107,589	118,212	118,030	124,800	105,209

[a] Statistik des Bergbaues in Österreich, Wien.
[b] Statistics not available. Estimate only.
[c] Estimate by "the Italian bureau of mines." Dennis, A. P., Commerce Repts., No. 43, p. 1040, 1920.
[d] Ungar. statist. Jahrb., Budapest.
[e] Riv. servizio min., Roma.
[f] Min. Jour., London.
[g] Metallgesellschaft, Frankfurt-am-Main.
[h] Statistics not available. Estimate based on oral information from Russian Special Commission to United States in 1917.
[i] Estadística minera de España, Madrid.

PRICES.

Average yearly prices of quicksilver in the United States and the United Kingdom, 1910–1919.

[Per flask of 75 pounds.]

Year.	San Francisco [a] (domestic).	New York. [b]	London. [c]	Year.	San Francisco [a] (domestic).	New York. [b]	London. [c]
			£ s. d.				£ s. d.
1910	$46.51	$47.06	8 16 0	1915	$85.80	$87.01	14 10 8
1911	46.01	46.54	8 4 11	1916	125.89	125.49	17 2 10
1912	42.05	42.46	8 2 10	1917	105.32	106.30	22 4 3
1913	40.23	39.54	7 9 2	1918	117.50	123.47	[d]
1914	49.05	48.31	[e] 7 15 0	1919	90.29	92.15	20 9 5½

[a] Min. and Sci. Press, San Francisco.
[b] Eng. and Min. Jour., New York.
[c] Min. Jour. (London).
[d] Quoted as "nominal" only.
[e] Metal exchange closed about three months after outbreak of war. Average based on 37 weeks only.

Prices of domestic quicksilver at San Francisco, 1914–1919, by months.

[Per flask of 75 pounds.]

Month.	1914	1915	1916	1917	1918	1919
January	$39.25	$51.90	$222.00	$81.00	$128.06	$103.75
February	39.00	60.00	295.00	126.25	118.00	90.00
March	39.00	78.00	219.00	113.75	112.00	72.80
April	38.90	77.50	141.60	114.50	115.00	73.12
May	39.00	75.00	90.00	104.00	110.00	84.80
June	38.60	90.00	74.70	85.50	112.00	91.40
July	37.50	95.00	81.20	102.00	120.00	100.00
August	80.00	93.75	74.50	115.00	120.00	103.00
September	[a] 76.25	91.00	75.00	112.00	120.00	102.60
October	53.00	92.90	78.20	102.00	120.00	86.00
November	55.00	101.50	79.50	102.50	120.00	78.00
December	53.10	123.00	80.00	117.42	115.00	95.00

[a] Market fluctuated greatly at outbreak of European war.

RADIUM.

[See under Uranium and vanadium ores.]

SALT.

SUPPLY.

Supplies of salt for consumption in the United States, 1900–1919, in short tons.

	1900	1910	1913	1918	1919
Domestic production	2,921,708	4,242,792	4,815,902	7,238,744	6,882,902
Imports	199,909	137,103	154,765	40,290	59,514
Total supply	3,121,617	4,379,895	4,970,667	7,279,034	6,942,416
Exports	7,511	49,013	70,289	136,783	119,416
Domestic consumption	3,114,106	4,330,882	4,900,378	7,142,251	6,823,000
Comparison with preceding year	+178,449	+6,444	+157,502	+213,145	−319,251
Percentage of imports to total consumption	6.4	3.2	3.2	0.6	0.9

PRODUCTION.

Domestic salt marketed in the United States, 1913–1919.

Year.	Quantity (short tons).				Total value.	Average price per ton.
	Manufactured (evaporated).	In brine.	Rock salt.	Total.		
1913	2,131,229	1,622,382	1,062,291	4,815,902	$10,123,139	$2.10
1914	2,159,094	1,652,758	1,060,804	4,872,656	10,197,417	2.09
1915	2,335,823	1,851,199	1,165,387	5,352,409	11,747,686	2.19
1916	2,454,836	2,539,717	1,368,353	6,362,906	13,645,947	2.14
1917	2,482,564	2,890,588	1,605,025	6,978,177	19,940,442	2.86
1918	2,724,203	2,830,600	1,683,941	7,238,744	26,940,361	3.72
1919	2,390,206	2,850,639	1,642,057	6,882,902	27,074,694	3.93

SAND AND GRAVEL.

PRODUCTION.

Sand and gravel produced in the United States, 1913–1919.[a]

Year.	Glass sand.		Molding sand.		Building sand.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	1,791,800	$1,895,991	3,563,583	$2,230,217	25,397,383	$8,007,949
1914	1,619,649	1,568,030	2,751,209	1,756,383	24,003,962	7,688,774
1915	1,884,044	1,606,640	3,585,746	2,123,203	22,921,426	6,884,267
1916	2,018,317	1,957,797	4,662,649	3,219,839	27,193,462	8,569,675
1917	1,942,675	2,685,014	4,660,968	4,303,809	25,374,987	9,837,688
1918	2,172,887	4,209,728	4,910,178	5,121,865	19,686,885	9,772,556
1919[a]	1,827,409	3,593,371	3,774,612	4,153,990	21,969,736	12,296,664

Year.	Other sand.		Gravel.		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	7,941,389	$2,973,688	40,861,694	$9,109,663	79,555,849	$24,217,508
1914	9,577,628	3,112,175	41,329,287	9,721,637	79,281,735	23,846,999
1915	7,550,773	2,558,991	40,661,314	9,948,516	76,603,303	23,121,617
1916	9,089,550	3,842,538	46,127,754	12,220,146	89,091,732	29,809,995
1917	8,866,876	4,962,232	35,573,819	13,508,189	76,419,325	35,296,932
1918	6,349,870	5,259,620	28,704,606	13,563,310	61,824,426	37,927,079
1919[a]	8,397,979	6,345,654	34,606,671	19,561,877	70,576,407	45,951,556

[a] It has been possible to make the canvass for 1919 more complete than ever before, and the result is that about 2,000,000 short tons of sand and gravel, valued at nearly $1,000,000, has been reported by producers whose output has not heretofore been ascertained by the Survey. This fact should be borne in mind in making comparisons between the figures for 1919 and those for former years. The canvass for 1919 shows that practically all those who reported production for 1918 state that there was an increased demand for sand and gravel in 1919 which they were unable to meet because of car shortage.

IMPORTS AND EXPORTS.

Value of sand and gravel imported into and exported from the United States, 1913–1919.[a]

Year.	Imports.	Exports.	Year.	Imports.	Exports.
1913	$172,257	(b)	1917	$142,586	$494,251
1914	139,675	(b)	1918	91,465	619,414
1915	96,754	(b)	1919	126,586	382,070
1916	87,144	$233,310			

[a] These imports and exports are mostly building sand shipped from and to Canada.
[b] Not reported separately.

SAND-LIME BRICK.

PRODUCTION.

Sand-lime brick sold in the United States, 1910–1919.

Year.	Number of operators reporting sales.	Quantity (thousands).	Value of product.	Year.	Number of operators reporting sales.	Quantity (thousands).	Value of product.
1910	76	172,507	$1,169,153	1915	56	179,643	$1,135,104
1911	66	142,963	897,664	1916	53	227,344	1,474,073
1912	71	178,541	1,200,223	1917	47	187,546	1,420,330
1913	68	189,659	1,238,325	1918	42	98,399	883,929
1914	62	172,629	1,058,512	1919	35	146,947	1,705,163

IMPORTS AND EXPORTS.

Imports and exports of sand-lime brick are not reported separately.

SELENIUM.

PRODUCTION.

The output of selenium in 1919 was 60,025 pounds, valued at $125,966, as against 103,694 pounds, valued at $206,540, in 1918, and 39,630 pounds, valued at $70,000, in 1917. Most of the selenium produced is a by-product in the electrolytic refining of copper.

IMPORTS.

Selenium and selenium salts imported for consumption in the United States, 1913–1919.

1913	$320	1917	$2,236
1914	43	1918	
1915	59	1919	25,866
1916	302		

SILICA BRICK.

PRODUCTION.

Silica brick sold in the United States, 1910–1919.

Year.	Quantity (thousands).	Value of product.	Average price per thousand.	Year.	Quantity (thousands).	Value of product.	Average price per thousand.
1910	145,779	$3,289,028	$22.56	1915	130,244	$3,039,869	$23.34
1911	104,483	2,520,816	24.13	1916	232,673	6,369,256	27.37
1912	135,578	2,923,174	21.56	1917	327,030	15,510,595	47.43
1913	174,246	3,815,806	21.90	1918	336,562	19,987,803	59.39
1914	129,693	2,951,525	22.76	1919	211,420	10,914,898	51.63

IMPORTS AND EXPORTS.

Imports and exports of silica brick are not reported separately.

SILICA (QUARTZ).

PRODUCTION.

Silica sold for pottery, paints, fillers, polishers, abrasives, and other uses in the United States, 1917–1919.

Material.	1917		1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Quartz (vein quartz, pegmatite, and quartzite)	142,673	$318,069	71,740	$259,330	63,332	$373,571
Sand and sandstone [a]	532,454	1,195,142	98,956	620,584	47,277	288,890
Tripoli	26,069	338,188	19,982	199,854	24,292	181,541
Diatomaceous earth [b]	3,033	31,368	2,965	24,947	42,642	531,690
	704,229	1,882,767	193,643	1,104,715	177,543	1,375,962

[a] Includes only finely ground material. Figures probably incomplete.
[b] Excludes in 1917 and 1918 California product used for filters and as insulating and fireproofing material, figures for which the Survey is not at liberty to publish.

IMPORTS AND EXPORTS.

No imports or exports of silica (quartz) are reported.

SILVER.

[See under Gold and silver.]

SLATE.

PRODUCTION.

Slate sold in the United States, 1913–1919, by uses.

Year.	Roofing slate.			Mill stock.			Other uses (value).	Total value.
	Number of squares (100 sq. ft.).	Value.	Average price per square.	Quantity (square feet).	Value.	Average price per square foot.		
1913	1,113,944	$4,461,062	$4.00	6,312,011	$1,233,838	$0.195	$480,576	$6,175,476
1914	1,019,553	4,160,832	4.08	5,361,925	977,930	.182	568,025	5,706,787
1915	967,880	3,746,334	3.87	4,576,112	819,672	.179	392,909	4,958,915
1916	835,873	3,408,934	4.08	5,782,842	1,177,260	.20	752,643	5,338,837
1917	703,667	3,411,740	4.85	5,478,151	1,277,249	.23	1,060,977	5,749,966
1918	379,817	2,219,131	5.84	4,841,133	1,498,164	.31	321,475	[a] 4,038,770
1919	454,357	3,085,957	6.79	3,965,281	1,316,436	.33	1,628,255	6,030.648

[a] Excludes the value of slate granules.

Slate sold in the United States, 1915–1919, by States.

State.	1915	1916	1917	1918	1919
California	.....	(a)	(a)	(a)	.....
Maine	$243,312	$342,474	$322,685	$287,891	$279,274
Maryland	91,277	71,737	67,938	42,113	71,593
New Jersey	(a)	(a)	(a)	(a)	.....
New York	127,603	21,345	55,207	[b] 11,383	450,379
Pennsylvania	3,044,269	3,124,743	3,306,704	2,304,647	2,885,072
Tennessee	.....	.....	(a)	(a)	.....
Utah	(a)	(a)	(a)	(c)	400
Vermont	1,234,891	1,607,901	1,858,307	[b] 1,279,987	2,143,648
Virginia	210,612	165,483	135,380	109,723	200,282
Undistributed [d]	6,951	5,154	3,745	3,026	.....
	4,958,915	5,338,837	5,749,966	[b] 4,038,770	6,030,648

[a] Included under "Undistributed."
[b] Exclusive of value of slate granules.
[c] Slate granules only produced and value excluded from total for United States in 1918.
[d] 1915: New Jersey and Utah; 1916: California, New Jersey, and Utah; 1917: California, New Jersey, Tennessee, and Utah; 1918: California, New Jersey, and Tennessee.

IMPORTS.

Imports of slate are negligible, being valued at $691 in 1919, as compared with $321 in 1918 and $1,024 in 1917.

EXPORTS.

Roofing slate exported from the United States, 1913–1919.

1913	$226,413	1917	$27,113
1914	139,125	1918	65,224
1915	46,137	1919	55,164
1916	27,630		

Slate other than roofing exported from the United States, 1917–1919, by uses.

[Statistics collected by U. S. Geological Survey from shippers.]

Use.	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
School slates.....cases [a]	22,682	$136,122	16,521	$111,680	13,763	$137,411
Slate pencils.....do....	5,000	33,060	3,450	35,945	.....	.....
Electrical slate...square feet..	28,136	21,059	35,883	35,478	41,485	26,991
Blackboards.....do....	60,390	11,925	12,287	2,590	34,841	7,605
Billiard tables.....do....	6,811	1,202	4,478	1,345	(b)	(b)
Structural.....do....	4,040	1,222	1,285	525	[b] 11,512	[b] 3,884
	.....	204,590	.....	187,563	.....	175,891

[a] Cases weigh from 130 to 165 pounds each; average is 135 pounds.
[b] Slate for use in billiard tables included under structural slate.

SOAPSTONE.

[See under Talc and soapstone.]

SODIUM COMPOUNDS.

PRODUCTION.

Sodium and sodium compounds produced in the United States, 1918 and 1919.

Product.	1918		1919	
	Quantity (short tons).	Value.	Quantity. (short tons).	Value.
Sodium (metal)	264	$153,437	(a)	(a)
Sodium acetate	2,622	460,783	2,426	$311,175
Sodium benzoate	203	886,058	126	230,224
Sodium bicarbonate	118,535	3,293,153	134,962	3,486,635
Sodium bichromate	28,334	9,868,118	26,526	6,233,566
Sodium bisulphite and sodium sulphite	16,362	478,482	11,819	687,750
Sodium bromide	574	438,730	499	493,319
Sodium carbonate:				
Soda ash	1,390,628	35,635,520	981,054	29,895,343
Monohydrate and sesquicarbonate	22,678	482,958	31,278	714,930
Sal soda	82,465	2,020,271	80,090	2,229,994
Sodium chlorate and sodium perborate	2,413	1,004,250	1,210	62,980
Sodium chloride (common salt):				
Salt in brine	2,830,600	1,245,265	2,850,639	1,423,424
Rock salt	1,683,941	5,684,661	1,642,057	6,240,450
Evaporated salt	2,724,203	20,010,435	2,390,206	19,410,820
Sodium citrate, tartrate, and bitartrate	(a)	(a)	33	58,128
Sodium cyanide, sodium peroxide, and sodium iodate	9,077	5,361,000	9,148	4,515,106
Sodium ferrocyanide	4,525	2,690,110	3,437	1,346,285
Sodium fluoride, acid sodium fluoride, and sodium fluosilicate (silicofluoride)	1,879	387,224	1,171	244,004
Sodium hydroxide (caustic soda)	513,363	31,854,470	355,466	22,196,898
Sodium iodide	(a)	(a)	12	86,985
Sodium nitrate (refined)	.....	.....	8,040	816,647
Sodium nitrite	1,701	609,779	1,182	265,121
Sodium phosphate (including all sodium phosphates)	15,620	1,427,947	14,760	1,733,996
Sodium silicate	317,161	5,870,973	300,138	5,879,628
Sodium sulphate:				
Salt cake	141,054	2,844,897	129,042	2,019,460
Glauber's salt	50,715	1,041,070	47,730	877,060
Niter cake	143,155	595,660	83,402	271,424
Sodium sulphide	43,490	2,293,304	45,448	2,645,181
Sodium tetraborate (borax)	26,673	3,909,565	28,518	4,351,891
Sodium thiosulphate (hyposulphite)	26,868	1,051,623	32,212	1,709,223
Miscellaneous sodium compounds	390	1,188,792	841	756,548
	10,199,493	142,788,535	9,213,472	121,194,195

[a] Included under "Miscellaneous sodium compounds."

Sodium salts derived from natural sources in the United States, 1918 and 1919, by varieties.

Salt.	1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Sodium chloride (common salt):				
Salt in brine	2,830,600	$1,245,265	2,850,639	$1,423,424
Rock salt	1,683,941	5,684,661	1,642,057	6,240,450
Evaporated salt	2,724,203	20,010,435	2,390,206	19,410,820
Sodium carbonate, sodium bicarbonate, sodium sulphate, and borax	24,053	992,788	29,120	874,083
	7,262,797	27,933,149	6,912,022	27,948,777

Crude borates produced in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	42,357	$1,201,842	1915	67,003	$1,677,099
1911	53,330	1,569,151	1916	103,525	2,409,459
1912	42,315	1,127,813	1917	108,875	3,609,632
1913	58,051	1,491,530	1918	88,794	2,263,230
1914	62,400	1,464,400	1919 [a]	66,146	1,380,000

[a] Including naturally occurring borax.

IMPORTS.

Sodium salts imported for domestic consumption in the United States, 1918 and 1919, by varieties.

Salt.	1918		1919	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Sodium arsenate	35	$88		
Sodium benzoate	54,150	11,469	68,566	$14,435
Sodium bicarbonate [a]	12,383	629	17,122	3,616
Sodium carbonate:				
Soda ash	1,445	29	829,266	12,998
Monohydrate and sesquicarbonate	44,800	1,281		
Sal soda	25	2	45,060	1,182
Sodium chlorate	44,810	8,066	39,022	3,814
Sodium chloride (common salt)	80,580,700	281,468	119,028,200	242,704
Sodium chromate and sodium bichromate	5,102	1,184		
Sodium cyanide	69,279	12,615	5,174,831	305,426
Sodium ferrocyanide (yellow prussiate of soda)	271,063	98,505	1,299,521	218,222
Sodium hydroxide or caustic soda	2,002	193	42,724	6,888
Sodium nitrate or Chilean nitrate	4,138,758,400	90,216,935	912,932,160	19,558,963
Sodium nitrite	2,857,631	289,182	2,550,779	246,729
Sodium phosphate			56	22
Sodium silicate	464,461	9,902	931,086	25,421
Sodium sulphate, crude, or salt cake, and niter cake	138,880	947		
Sodium sulphide	112,821	4,673	1,668,562	54,251
Sodium sulphite	30,450	1,287	58,524	2,376
Sodium tetraborate, or refined borax	2	1	378	155
Sodium thiosulphate	1,120	975	27,616	6,312
	4,223,449,559	90,939,431	1,044,713,473	20,703,514

[a] Or supercarbonate, or saleratus, and other salts containing 50 per cent or more of sodium bicarbonate.

EXPORTS.

Domestic sodium salts exported from the United States, 1914-1919.

1914	[a]$1,320,963	1917	$23,384,969
1915	7,725,034	1918	22,291,735
1916	17,571,439	1919	18,545,420

[a] Figures cover six months, July–December.

Domestic sodium salts exported from the United States, 1918 and 1919, by varieties.

Salt.	1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Sodium carbonate:				
Soda ash	119,217	$7,805,550	50,481	$2,656,608
Sal soda	6,358	213,865	5,563	178,285
Sodium chloride (common salt)	136,783	1,677,577	119,416	1,396,625
Sodium hydroxide	48,689	5,602,813	82,118	6,748,762
Sodium silicate	14,125	404,796	12,150	338,818
All other sodium salts	.....	6,587,134	.....	7,226,322
	.....	22,291,735	.....	18,545,420

Foreign sodium salts reexported from the United States, 1915–1919.

Year.	Sodium chloride (common salt).		Sodium cyanide.		Sodium nitrate.		All other sodium salts.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Value.
1915	52	$31,841	949	$347,079	25,472	$1,123,761	$40,358
1916	7,448	61,525	111	58,265	60,079	3,432,273	193,086
1917	1,900	21,830	138	115,067	78,152	5,367,281	25,632
1918	723	13,903	(a)	145	61,271	5,204,413	73,402
1919	457	7,992	.....	.....	15,314	1,299,563	387,090

a 125 pounds.

STEEL.

[See under Iron ore, pig iron, and steel.]

STONE.

PRODUCTION.

Stone produced and sold in the United States, 1913–1919, by varieties.

Year.	Granite.		Basalt and related rocks (trap rock).		Sandstone.		Marble.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value	Quantity (short tons).	Value.
1913	(a)	$20,733,217	(a)	$9,134,494	(a)	$7,248,965	417,200	$7,870,890
1914	(a)	20,160,730	(a)	7,865,998	(a)	7,501,808	490,570	8,121,412
1915	(a)	17,864,439	(a)	8,489,222	(a)	6,095,800	428,000	6,916,025
1916	9,270,800	17,456,838	10,233,640	7,666,297	4,681,590	5,603,778	409,970	7,033,171
1917	5,564,200	15,544,957	9,103,580	7,570,885	3,880,500	5,512,421	310,130	6,330,387
1918	3,827,400	14,466,423	6,859,200	7,782,280	2,858,100	4,529,298	305,720	5,496,389
1919	4,221,220	19,345,714	7,410,770	8,944,686	2,623,270	5,283,842	333,400	8,042,297

Year.	Limestone.		Miscellaneous.b		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	(a)	$38,745,429	.....	.....	(a)	$83,732,995
1914	(a)	33,894,155	.....	.....	(a)	77,544,103
1915	(a)	35,229,866	.....	.....	(a)	74,595,352
1916	67,235,000	41,309,599	.....	.....	91,831,000	79,069,683
1917	63,481,500	46,263,379	1,234,990	$993,642	83,574,900	82,215,671
1918	53,868,200	49,453,006	844,740	973,034	68,563,360	82,700,430
1919	49,759,800	53,171,701	1,190,540	1,920,903	65,539,000	96,709,143

a Figures of quantity not available.
b Includes mica schist used for furnace lining, conglomerate, argillite, and various light volcanic rocks used mainly for crushed stone, which can not be properly classified in any of the main groups.

Stone produced and sold in the United States, 1918–1919, by uses.

Use.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Building stone.....cubic feet..	8,616,900	$7,454,973	12,764,516	$10,613,683
Approximate equivalent in short tons.....	719,200	.....	996,840	.....
Monumental stone.....cubic feet..	4,072,343	9,912,167	4,759,995	15,042,369
Approximate equivalent in short tons.....	343,100	.....	399,070	.....
Paving blocks.....number..	28,516,910	1,714,011	35,630,885	2,590,690
Approximate equivalent in short tons.....	298,650	.....	386,530	.....
Curbing.....cubic feet..	951,650	661,188	1,826,663	1,288,828
Approximate equivalent in short tons.....	80,570	.....	150,060	.....
Flagging.....cubic feet..	798,934	373,729	962,173	502,871
Approximate equivalent in short tons.....	65,900	.....	78,870	.....
Rubble.....short tons..	482,365	635,895	601,146	818,565
Riprap.....do....	2,273,852	1,923,154	1,751,677	1,922,823
Crushed stone.....do....	29,373,342	27,951,393	33,673,339	36,405,186
Furnace flux (limestone and marble).....long tons..	23,917,040	23,512,635	19,031,520	19,419,438
Equivalent in short tons.....	26,787,085	.....	21,315,300	.....
Refractory stone (ganister, mica schist, and dolomite) .....short tons..	1,825,183	2,363,154	1,060,741	1,429,775
Manufacturing industries [a].....do....	4,838,108	4,194,013	4,370,936	5,179,387
Other uses [b].....do....	1,476,005	2,004,118	754,491	1,495,528
Total expressed approximately in short tons.....	68,563,360	82,700,430	65,539,000	96,709,143

[a] Includes stone used for agriculture, in alkali works, sugar factories, glassworks, paper mills, and other chemical industries.

[b] Includes stone sold for asphalt filler, whiting or chalk substitute, poultry grit, roofing material, stucco and terrazzo work, filter stone, and other uses not specified.

IMPORTS.

Stone imported for consumption in the United States, 1917–1919.

Kind.	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Marble:						
In blocks, rough, etc.....cubic feet..	267,250	$428,396	96,478	$192,641	209,945	$593,340
Sawed.....do....	9	25	.....	.....	9	90
Slabs or paving tiles.....square feet..	124,935	27,884	26,118	5,304	104,102	25,841
All other manufactures.....	.....	87,177	.....	28,798	.....	46,622
Mosaic cubes:						
Loose.....	.....	13,434	.....	5,508	.....	3,888
Attached to paper.....	.....	.....	.....	.....	.....	974
	.....	536,916	.....	232,251	.....	670,755
Onyx:						
In blocks, rough, etc.....cubic feet..	6,935	22,439	1,398	3,046	2,040	9,517
Slabs or paving tiles.....square feet..	5,976	1,595	.....	.....	.....	.....
All other manufactures.....	.....	472	.....	133	.....	2,053
	.....	24,506	.....	3,179	.....	11,570
Granite:						
Dressed.....	.....	25,119	.....	1,328	.....	9,983
Rough.....cubic feet..	18,982	9,923	18,473	9,653	23,240	17,796
	.....	35,042	.....	10,981	.....	27,779
Stone (other):						
Dressed.....	.....	15,296	.....	5,060	.....	21,444
Rough (monumental or building stone).....cubic feet..	53,537	40,330	11,995	12,716	13,807	14,228
Rough (other).....	.....	9,385	.....	4,390	.....	42,185
	.....	65,011	.....	22,166	.....	77,857
Grand total.....	.....	681,475	.....	268,577	.....	787,961

EXPORTS.

Stone exported from the United States, 1913–1919.

Kind.	1913	1914	1915	1916	1917	1918	1919
Marble and stone, unmanufactured	$606,745	$559,556	$400,510	$403,303	$572,097	$552,261	$770,392
All other, manufactured	1,250,147	803,686	635,614	1,077,447	1,108,185	1,208,164	1,508,997
	1,856,892	1,363,242	1,036,124	1,480,750	1,680,282	1,760,425	2,279,389

STRONTIUM.

PRODUCTION.

Domestic strontium ore marketed in the United States, 1916–1919.

Year.	Quantity (short tons).	Value.
1916	250	$3,650
1917	4,035	87,700
1918	400	20,000
1919	----	----

The Geological Survey has no record of the production of domestic strontium ore prior to 1916.

IMPORTS.

Value of oxide and protoxide of strontium and strontianite, mineral carbonate of strontium, imported for consumption in the United States, 1913–1919.

Year.	Value.	Year.	Value.
1913	$2,284	1917	$23,216
1914	1,016	1918	2,459
1915	6,411	1919	3,380
1916	11,049		

EXPORTS.

No exports of strontium ore have been reported.

SULPHUR.

PRODUCTION.

Sulphur produced and shipped in the United States, 1910–1919.

Year.	Mined.	Shipped.		Year.	Mined.	Shipped.	
	Quantity (long tons).	Quantity (long tons).	Approximate value.		Quantity (long tons).	Quantity (long tons).	Approximate value.
1910	247,060	250,919	$4,522,000	1915	520,582	293,803	$4,959,000
1911	205,066	253,795	4,573,000	1916	649,683	766,835	12,246,000
1912	787,735	305,390	5,289,000	1917	1,134,412	1,120,378	23,987,000
1913	491,080	319,333	5,617,000	1918	1,353,525	1,266,709	27,868,000
1914	417,690	341,985	6,214,000	1919	1,190,575	678,257	10,252,000

IMPORTS.

Sulphur imported and entered for consumption in the United States, 1913–1919.

Year.	Crude.		Flowers of sulphur.		Refined.		All other.[a]		Total.	
	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.	Quantity (long tons).	Value.
1913	15,122	$286,209	5,899	$115,574	1,234	$29,091	350	$17,690	22,605	$448,564
1914	23,610	398,984	621	17,214	1,800	47,568	104	14,171	26,135	477,937
1915	24,647	405,990	647	23,146	988	30,335	85	12,987	26,367	472,458
1916	21,289	358,416	425	18,408	455	15,020	66	12,940	22,235	404,784
1917	973	20,176	.....	.....	.....	.....	42	9,164	1,015	29,340
1918	55	1,692	.....	.....	.....	.....	27	7,850	82	9,542
1919	77	1,997	.....	.....	.....	15	21	6,621	101	8,633

[a] Includes sulphur lac and other grades not otherwise provided for, but not pyrite.

EXPORTS.

Sulphur exported from the United States, 1910–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1910	30,742	$552,941	1915	37,312	$724,679
1911	28,103	545,420	1916	128,755	2,505,857
1912	57,736	1,076,414	1917	152,736	3,500,819
1913	89,221	1,599,761	1918	131,092	3,626,638
1914	98,163	1,807,324	1919	224,712	6,325,552

TALC AND SOAPSTONE.

TALC.

PRODUCTION.

Domestic talc sold in the United States, 1913–1919, by classes.

Year.	Rough (crude).		Manufactured into pencils and blanks.[a]		Ground.[b]		Total.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	2,454	$11,597	138	$36,272	146,679	$1,232,151	149,271	$1,280,020
1914	2,634	17,088	698	59,380	147,756	1,264,406	151,088	1,340,874
1915	8,235	58,867	39	11,941	158,062	1,330,389	166,336	1,401,197
1916	11,299	106,928	828	102,674	181,182	1,553,240	193,309	1,762,842
1917	12,269	68,440	5,781	176,404	180,563	1,644,828	198,613	1,889,672
1918	14,763	121,228	945	114,002	177,269	1,869,730	192,977	2,104,960
1919	15,625	73,437	921	147,339	151,793	1,601,736	168,339	1,822,512

[a] Includes slate pencils and metal workers' crayons and blanks used in making acetylene burners and other objects.

[b] For foundry facings, filler for paper, paint, and rubber goods, toilet powder, foot ease, lubricators, for dressing skins and leather, etc.

World's production of talc, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	Percentage in 1918.
United States	135,417	137,066	150,898	175,368	180,180	173,706	59
France [a]	60,175	(a)	(a)	(a)	(a)	57,588	19
Italy [b]	24,001	22,477	23,931	27,483	21,863	[b] 23,951	8
Canada [c]	11,113	9,804	10,782	11,888	14,336	16,502	6
Austria [d]	[d] 16,000	[d] 15,000	[d] 12,000	[d] 12,000	[d] 12,000	[d] 12,000	4
Norway [e]	1,500	2,100	2,990	5,500	.....	3,023	1
Spain [f]	4,407	4,612	963	3,556	3,450	3,328	1
Germany [g]	.....	.....	.....	.....	.....	3,000	1
India [h]	2,565	1,015	1,094	1,233	7,954	[h] 2,772	1
British South Africa [i]	.....	.....	.....	120	712	608	.....
						296,478	100

[a] Statistique de l'industrie minérale en France pour l'année, 1913, p. 61. (Statistics from 1914 to 1917 not available. Average production for 1912 and 1913 given under 1918.)

[b] Rivista del Servizio minerario, 1917, p. 63. Not available for 1918, but the average crude for 1913–1917 is 23,951 tons.

[c] Canada Dept. Mines, Mines Branch, Ann. Repts., 1913–1918.

[d] Statistics for Austria not available for years mentioned in table. Department of Commerce reports talc exported from Austria-Hungary in 1913 as 80,828 metric quintals, or 8,083 metric tons. Much talc is used in Austria, especially for paper. If we assume that somewhat less than half of the total output is used in Austria, the total production in 1913 was about 16,000 tons. As talc is rather a peace mineral and war delayed production, the output in 1915–1918, inclusive, would probably average less than 12,000 metric tons annually, although the capacity of the mines apparently is greater.

[e] Norges Officielle Statistik—Norges Bergverkskrift.

[f] Estadística minera de España, 1913–1918.

[g] Mineral Industry, 1918.

[h] India Geol. Survey Rec., vols. 46–49. Statistics not available for 1918. Average for 1913–1917 is 2,772 metric tons.

[i] Ann. Repts. Government Mining Engineer, Union of South Africa, Dept. Mines, 1917.

IMPORTS.

Talc imported for consumption in the United States, 1913–1919.

Year.	Crude and unground steatite and French chalk. [a]			Ground talc, or steatite cut, powdered, washed, or pulverized. [b]			French chalk cut, powdered, washed, or pulverized.			Total.	
	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.	Average price per ton.	Quantity (short tons).	Value.
1913	(c)	(c)	.....	(c)	(c)	.....	(c)	(c)	.....	13,770	$137,680
1914	(c)	(c)	.....	(c)	(c)	.....	(c)	(c)	.....	15,734	177,321
1915	2,117	$12,967	$6.12	15,952	$186,873	$11.71	(c)	(c)	.....	18,069	199,840
1916	2,027	12,645	6.24	16,855	218,230	12.95	(c)	(c)	.....	18,882	230,875
1917	2,452	10,710	4.37	16,157	258,787	16.02	(c)	(c)	.....	18,609	269,497
1918	1,434	9,253	6.45	12,735	251,323	19.73	(c)	(c)	.....	14,169	260,576
1919	1,641	10,105	6.16	12,958	248,576	19.18	3	$323	$107.67	14,602	259,004

[a] Duty free. [b] 15 per cent duty. [c] Not separately classified.

EXPORTS.

No exports of talc are reported.

SOAPSTONE.

PRODUCTION.

Domestic soapstone sold in the United States, 1913–1919.

Year.	Quantity (shorttons).	Value.	Year.	Quantity (shorttons).	Value.
1913	26,562	$628,077	1917	20,235	(a)
1914	21,208	524,213	1918	15,330	$576,059
1915	20,555	490,385	1919	16,504	530,163
1916	19,652	490,961			

[a] Unpublished to avoid revealing value of business of one firm which constitutes bulk of output of three producers.

IMPORTS AND EXPORTS.

Imports and exports of soapstone are not separately reported.

TANTALUM.

For several years prior to 1918 there had been no market for tantalum or columbium minerals, and they had therefore not been produced. There had, however, been a continuously active interest in research in all lines of metallurgy, and as its name suggests this element has tantalized the investigator with its attractive qualities, such as resistance to the action of most acids and many other chemicals and of the air, its high tensile strength, malleability, and high melting point. In 1918 the demand for tantalum and columbium salts for experimental purposes became large enough to allow A. T. Roos, of Deadwood, S. Dak., to market 4,500 pounds of columbite, valued at $2,250. The columbite, which carried about 50 per cent Ta_2O_5, was taken from the pegmatite dike on the Bob Ingersoll claim, a few miles west of Keystone, S. Dak., on the road to Hill City. In 1919 only 300 pounds, valued at $90, was shipped, but orders for several hundred pounds had been received, and larger shipments were expected to be made early in 1920.

No tantalum or "tantalum steel-hardening ores" were imported in 1919, and no separate record of exports is kept.

TELLURIUM.

Only one refiner, the Raritan Copper Works, reported a production of tellurium in 1919, as was also the case in 1918, and the Survey is not at liberty to publish figures. There continues to be a small demand for tellurium, but the stocks are apparently large as compared with the annual consumption. Tellurium is a by-product from the electrolytic refining of copper.

Imports and exports of tellurium are not reported.

THORIUM MINERALS.

SUPPLY.

Monazite sand produced in the United States and monazite sand and thorium nitrate imported for consumption, 1910–1919.

Year.	Monazite sand produced in the United States		Imports of monazite sand.		Imports of thorium nitrate.		Price per pound of thorium nitrate.[a]
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	
1910	99,301	$12,006	453,554	$39,699	124,808	$219,615	$3.10
1911			705,149	60,542	121,111	238,841	3.00
1912			556,959	47,334	117,485	225,386	3.00
1913			817,810	65,848	119,044	230,628	2.73
1914			770,842	61,595	101,927	239,376	2.98
1915	36,000	3,600	1,873,971	161,456	67,247	170,268	[b] 4.50
1916	37,872	3,400	2,436,197	188,383	909	3,884	[c] 6.25
1917	22,000	1,760	5,828,270	355,017	1,188	2,359	[d] 8.00
1918			2,994,515	204,661			[e] 8.00
1919	(f)	(f)	632,568	48,768	3,307	5,250	[g] 3.75

[a] The figures for 1915 to 1919 were kindly furnished by Dr. Hugo Lieber, 23 East Twenty-sixth Street, New York City.
[b] The prices for 1915 ranged from $3.75 to $6.
[c] The prices for 1916 ranged from $4.75 to $8.50.
[d] The prices for 1917 ranged from $7.00 to $8.00.
[e] The prices for 1918 ranged from $8.00 to $8.25.
[f] Only one producer and Survey not at liberty to publish figures.
[g] The prices for 1919 ranged from $3.75 to $8.00.

WORLD'S PRODUCTION.

World's production of monazite sand, 1913–1919.

Year.	United States.		Brazil.		India.		Total.	
	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.	Short tons.	Metric tons.
1913	.....	.....	[a] 1,584	[a] 1,436	1,383	1,255	2,967	2,691
1914	.....	.....	[b] 661	[b] 600	1,328	1,204	1,989	1,804
1915	18	16	[b] 484	[b] 439	1,241	1,126	1,743	1,581
1916	19	17	.....	.....	1,448	1,314	1,467	1,331
1917	11	10	1,252	1,136	2,173	1,971	3,436	3,117
1918	.....	.....	551	500	2,371	2,151	2,922	2,651
1919	[c]	[c]	[d]	[d]	[d]	[d]	[d]	[d]

[a] To France, Germany, and the United States.
[b] All to the United States.
[c] Only one producer and Survey not at liberty to publish figures.
[d] Figures not yet available.

EXPORTS.

No exports of thorium minerals are reported.

TIN.

PRODUCTION.

The metallic tin obtainable from ore mined in the United States in 1919 amounted to about 56 short tons, valued at $73,400, as compared with 69 tons in 1918, valued at $118,500. As in the past, practically all of the ore was won in Alaska.

World's production of metallic tin, 1913–1919, in metric tons.

[Metal obtainable by smelting from concentrates.]

Country.	1913	1914	1915	1916	1917	1918	1919
Federated Malay States	50,930	49,820	47,520	44,570	40,470	37,970	37,460
British Protected Malay States	1,800	2,700	4,170	4,450	4,500	4,500	2,200
Bolivia	26,760	22,360	21,900	21,330	28,320	30,550	30,180
Banca	15,940	14,630	13,660	15,000	13,950	12,040	12,387
Billiton and Singkep	5,300	6,090	6,760	7,420	7,740	7,700	7,900
China	8,390	7,120	8,000	7,630	11,800	8,500	8,830
Siam	6,660	6,740	8,520	8,960	8,600	8,600	8,200
Nigeria	2,950	4,590	4,630	5,150	7,070	6,000	5,200
Australia	8,160	5,520	5,680	5,550	4,970	4,740	4,200
Cornwall	5,370	5,140	5,060	4,770	4,000	4,000	3,325
Union of South Africa	2,050	2,000	2,050	1,900	1,540	1,370	1,250
Other countries	1,400	1,500	1,500	1,700	1,800	2,000	2,000
	135,710	128,210	129,450	128,430	134,760	127,970	123,132

IMPORTS.

Tin imported into the United States, 1918 and 1919, by countries, in short tons.

[Metallic tin and tin obtainable from ore.]

Source.	1918	1919	Source.	1918	1919
Straits Settlements	36,067	28,790	Australia	3,787	1,648
England	9,038	10,622	China	1,603	.....
Dutch East Indies	10,670	2,525	Other countries	2,199	1,161
Bolivia (tin in concentrate)	11,600	12,200			
Hongkong	7,890	103		82,854	57,049

Tin imported as metal and entered for consumption in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	52,528	$33,913,255	1915	57,792	$38,736,909
1911	53,527	43,346,394	1916	69,035	51,802,232
1912	58,016	50,372,478	1917	72,166	63,860,340
1913	52,329	46,927,213	1918	71,254	93,144,218
1914	47,530	32,881,619	1919	44,849	50,890,019

Tin ore imported into the United States, 1916–1919.

Year.	Quantity (short tons).	Value.
1916	8,040	$4,032,460
1917	9,054	4,743,099
1918	18,394	11,444,401
1919	19,196	11,871,948

Imports of tin ore were not separately listed before 1916 and, except possibly for 1915, were negligible, as no foreign tin ores were smelted before 1916.

EXPORTS.

Exports of tin ore are insignificant and are not recorded.

PRICES.

Average monthly prices, in cents per pound, of Straits tin in New York, 1919.[a]

Month.	Average price per pound (cents).	Month.	Average price per pound (cents).
January	72.50	July	70.39
February	72.00	August	63.78
March	71.75	September	55.81
April	72.26	October	55.62
May	71.94	November	54.17
June	71.20	December	55.06

[a] Metal Statistics.

Average yearly prices, in cents per pound, of Straits tin in New York, 1910–1919.[1]

1910	34.27	1914	35.70	1917	61.65
1911	42.68	1915	38.66	1918	86.80
1912	46.43	1916	43.48	1919	65.54
1913	44.32				

TITANIUM MINERALS.

PRODUCTION.

Rutile, titanium dioxide (TiO_2), and ilmenite, titanium iron oxide ($TiFeO_3$), were produced in this country in 1919 by the American Rutile Co., at Roseland, Nelson County, Va. The company produced 102 short tons of rutile concentrates, carrying 94 to 96 per cent of TiO_2, valued at $20,400, and 106 tons of ilmenite concentrates, carrying 48 to 50 per cent of TiO_2, valued at $2,120. No production was made after August 1, 1919, as the company suspended operations for the erection of a new plant.

[1] Metal Statistics, 1920, p. 307.

In 1918 ilmenite was also produced and shipped from Pablo Beach, Fla., but information regarding operations at this plant during 1919 are not available for publication.

Titanium minerals produced in the United States, 1913–1919.

Year.	Rutile concentrates.		Ilmenite concentrates.		Total value.
	Quantity (short tons).	Percentage of TiO_2.	Quantity (short tons).	Percentage of TiO_2.	
1913	305	94–96	.....	.....	$49,000
1914	94	95	89	55	16,175
1915	250	94–96	300	55	27,500
1916	110	95	95	55	18,400
1917	206	93	1,339	53–55	45,637
1918	261	95	1,644	53–55	57,750
1919[a]	102	94–96	106	48–50	22,520

[a] Virginia production only; information regarding Florida not available for publication.

IMPORTS.

No titanium or "titanium steel-hardening ores" were imported during 1919. The imports of such steel-hardening ores during the last six months of 1918 were 1,606 pounds, valued at $221. No separate record of similar imports was kept prior to July, 1918. For imports of ferrotitanium see under ferroalloys.

EXPORTS.

No separate record of exports of titanium, "titanium steel-hardening ores," or ferrotitanium is kept.

TRIPOLI.

[See under Abrasive materials.]

TUNGSTEN.

SUPPLY.

Supplies of tungsten ores in the United States, 1913–1919, in short tons.

Year.	Production.	Imports for consumption.			Exports.[a]		Apparent consumption, plus stocks on hand.[b]
		Ore.	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.[c]	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.	
1913	1,537	449	740	2,151	.....	.....	3,688
1914	990	299	218	814	.....	.....	1,804
1915	2,332	1,776	8	1,942	.....	.....	4,274
1916	5,923	3,973	43	4,401	287	580	9,744
1917	6,144	4,876	1	5,284	1,162	2,420	9,008
1918	5,061	11,750	.....	12,729	616	1,265	16,525
1919	327	9,408	198	10,638	19	42	[d] 10,923

[a] No record of tungsten ore exported is at hand, although it is known that some has been shipped abroad.
[b] Production plus imports minus estimated equivalent in ore of the exports of tungsten and ferrotungsten. The apparent consumption is at best only an approximation.
[c] These items include the ore (considered as carrying 65 per cent of tungsten trioxide) and the tungsten and ferrotungsten (considered as equivalent to 2½ times their weight in ore carrying 60 per cent of tungsten trioxide). Chinese ore imported has been considered as 67.5 per cent of tungsten trioxide.
[d] Large stocks were on hand at the end of the year, probably equivalent to at least 8,000 short tons of concentrates carrying 60 per cent of WO_3.

PRODUCTION.

Concentrated tungsten ores (carrying 60 per cent tungsten trioxide) produced and sold in the United States, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	1,821	$832,992	1915	2,332	$4,100,000
1911	1,139	407,985	1916	5,923	12,074,000
1912	1,330	502,158	1917	6,144	6,783,000
1913	1,537	672,118	1918	5,061	7,049,300
1914	990	435,000	1919	327	353,900

Concentrated tungsten ores (carrying 60 per cent tungsten trioxide) produced and sold in the United States, 1916–1919, by States, in short tons.

State.	1916	1917	1918	1919	State.	1916	1917	1918	1919
Alaska	47	32	14	.....	New Mexico	16	(a)	4	.....
Arizona	218	150	213	50	South Dakota	239	270	201	.....
California	2,171	2,781	1,791	147	Other States [b]	41	59	30	.....
Colorado	2,401	2,707	1,910	130		5,923	6,144	5,061	327
Idaho	101	2	.....	.....					
Nevada	689	143	898	.....					

[a] Less than 1 ton.
[b] 1916: Connecticut, Missouri, Montana, Oregon, Utah, and Washington; 1917: Montana, Oregon, Utah, and Washington; 1918: Montana, Utah, and Washington.

World's production of tungsten ore, 1913 and 1915–1918, by metallogenic provinces and political areas, in metric tons of concentrates containing 60 per cent of WO_3.

Province and area.	1913	1915	1916	1917	1918
Asia.					
Japo-Korean province:					
Japan	257	389	730	763	629
Chosen (Korea)	.....	67	555	900	1,097
Chino-Malayan province:					
China	.....	35	109	1,361	10,187
Tonkin	127	333	343	433	450
Burma and Shan States	1,572	2,464	3,464	4,226	4,138
Siam	280	432	530	726	185
Unfederated Malay States	114	159	317	334	1,156
Federated Malay States	248	329	524	721	362
Billiton and Singkep	6	6	47	8	55
Indian province:					
India (excluding Burma)	.....	.....	46	68	44
	2,604	4,214	6,665	9,540	18,303
Australia.					
Australian province:					
Queensland	533	642	456	471	357
Northern Territory	32	36	137	252	275
New South Wales	200	99	313	268	279
Victoria	1	.....	1	.....	.....
South Australia	.....	.....	1	.....	.....
Tasmania	81	112	144	286	440
Western Australia	1	.....	.....	.....	.....
	848	889	1,052	1,277	1,351

World's production of tungsten ore, 1913 and 1915–1918, by metallogenic provinces and political areas, in metric tons of concentrates containing 60 per cent of WO_3—Contd.

Province and area.	1913	1915	1916	1917	1918
Oceania.					
Oceanic province:					
New Zealand	262	230	315	235	170
South America.					
Cordilleran province:					
Chile	.....	.....	9	2	.....
Argentina	575	169	854	1,056	613
Bolivia	297	859	3,288	4,215	3,703
Peru	324	413	532	427	251
Brazilian province:					
Brazil	.....	.....	5	.....	.....
	1,196	1,441	4,688	5,700	4,567
North America.					
Southwest American province:					
Mexico	.....	140	159	308	239
United States	1,394	2,116	5,330	5,545	4,578
Alaskan province:					
Alaska	.....	.....	43	29	13
Canadian province:					
Southeastern Canada	11	.....	.....	.....	15
	1,405	2,256	5,532	5,882	4,845
Europe.					
Scandinavian province:					
Norway	3	.....	1	1	.....
Sweden	.....	.....	.....	.....	3
Franco-Cornish province:					
England	197	360	407	245	308
France	160	126	162	261	212
Iberian province:					
Portugal	1,126	953	1,418	1,580	1,150
Spain	169	189	425	446	579
Italy	.....	.....	5	1	.....
Erzgebirgan province:					
Germany	96	193	330	300	300
Austria	52	14	10	10	10
Russian province;					
Russia	.....	.....	33	33	33
	1,803	1,835	2,791	2,877	2,595
Africa.					
South African province:					
South Africa	5	1	3	12	34
	8,123	10,866	21,046	25,523	31,865

IMPORTS.

Tungsten-bearing ores imported into the United States, 1918–1919, by countries.[a]

[General imports.]

1918			1919		
Country.	Quantity (short tons).	Value.	Country.	Quantity (short (tons.)	Value.
Argentina	536	$730,722	Argentina	145	$111,489
Bolivia	88	122,357	Bolivia	545	213,793
Brazil	3	4,177	Canada	20	12,750
Canada	56	115,863	Chile	985	685,414
Chile	1,250	1,209,864	China	2,810	1,624,539
China	2,385	2,068,636	Chosen	52	58,375
Colombia	56	65,124	Colombia	1	1,312
Costa Rica	18	19,081	Hongkong	3,403	2,249,011
Ecuador	6	9,979	Japan	846	856,017
France	29	3,400	Mexico	114	104,529
Hongkong	3,595	3,511,046	Panama	.....	172
Japan	1,362	1,700,332	Peru	431	299,101
Mexico	264	224,247	Straits Settlements	56	44,688
Panama	37	40,614		9,408	6,261,190
Peru	1,827	1,488,516			
Portugal	27	17,760			
Other British East Indies	19	13,071			
Salvador	40	60,042			
Siam	11	8,583			
	11,609	11,413,414			

[a] The ore from France probably originated in Portugal; that from Costa Rica, Panama, Salvador, Bolivia, Chile, Colombia, Ecuador, and most of that from Peru, is probably from Bolivia; that from China, practically all that from Hongkong and half of that from Japan is probably from China.

For imports of tungsten and ferrotungsten see also under ferroalloys.

EXPORTS.

No record of tungsten ore exported is at hand, although it is known that some has been shipped abroad. For exports of tungsten and ferrotungsten see also under ferroalloys.

PRICES.

Tungsten prices can be given only in a general way, for they are always more or less a matter of bargaining, and lots are sold on the same day at considerably different prices. In 1917 more attention was paid to quality than in preceding years, and the highest prices ranged from $25 to $28 a unit until the signing of the armistice on November 11, 1918, when a market that would have been dull anyway was further depressed by the weight of foreign ore. Lowest prices ranged from $15 at the beginning of 1918 to $11 at the close. Throughout 1919 the tungsten market continued dull, and prices varied slightly, the average being $7 a unit for spot Chinese ore, $10 for Bolivian wolframite, and $15 for western scheelite. In August, 1919, the tungsten bill, placing a duty of $10 a unit on tungsten ore and concentrates, was passed by the House of Representatives, but no action had been taken by the Senate when it adjourned in June, 1920.

URANIUM AND VANADIUM ORES.

PRODUCTION.

The output of uranium and vanadium ores in 1919 amounted to about 14,509 short tons containing 28.96 grams of radium (Ra), 95.7 tons of uranium (112.85 tons of U_3O_8), and 284.2 tons of vanadium. This is an increase over the output in 1918 which amounted to about 18,860 short tons of ore, containing 27.1 grams of radium (Ra), 89.5 tons of uranium (105.5 tons of U_3O_8), and 276 tons of vanadium. As in 1918, the value given to the output must be arbitrary and open to question, for the larger part of the uranium ore was produced by companies which themselves used the ore, and the vanadium ore was largely produced by the Primos Chemical Co., succeeded during the year by the Vanadium Corporation of America, which also reduced the ore, and by the Colorado Vanadium Co., which put up a treatment plant at Sawpit, San Miguel County, Colo., a few miles north of that of the Primos Chemical Co., at Vanadium (formerly Newmire). There is, however, a market for carnotite ore ($K_2O.2UO_3.V_2O_5.8H_2O$), which gives a basis for estimating the value of other similar ores. The approximate value, as ore, of the output in 1919 is estimated at $1,630,900. During the year 28.648 grams of radium in various salts was isolated against 21.7 grams in 1918.

Nearly 60 per cent of the world's vanadium comes from Peru, most of the other 40 per cent comes from the roscoelite and carnotite fields of southwestern Colorado and southeastern Utah. Small quantities of dechenite and other oxidized vanadium minerals have also been obtained in New Mexico, Nevada, and Arizona. A little mottramite has been mined in the former German East Africa, now under English control; tyuyamunite, a calcium carnotite, has been mined in Russian Afghanistan and treated at Petrograd; and vanadium has from time to time been extracted from the French iron slags.

The United States, as the largest steel-making nation, is the largest user of vanadium. England, Germany, and France buy ferrovanadium from this country and also buy ores when possible.

The Minaragra deposit is owned by an American company, the Vanadium Corporation of America, but of course the political control is wholly in the hands of Peru.

The exports from Peru and the production in the United States since 1912 have been as follows:

Approximate world's production of vanadium, 1912–1919.

Year.	Peru (exports of ore).			United States (production of ore and concentrates).
	Quantity (short tons).	Percentage of V_2O_5.	Vanadium contained (short tons).	Vanadium contained (short tons).
1912	3,360	45.00	847	300
1913				432
1914	17	45.00	4	452
1915	3,467	45.58	885	627
1916	3,801	40.00	851	460
1917	4,501	35.78	902	484
1918	2,407	19.10	257	276
1919	3,249	30.41	553	284

IMPORTS.

Uranium salts and oxide, including some radium salts, imported for consumption in the United States, 1913–1919.

Year.	Value.	Year.	Value.
1913	$34,319	1917	$2,930
1914	63,055	1918	[a] 274
1915	17,288	1919	[b] 12,960
1916	5,065		

[a] Radium salts only. In addition, 157 pounds of "uranium-radium steel-hardening ores," valued at $4,840, was imported.
[b] Composed of the value of 154 pounds of uranium salts and oxide ($1,309) and of 13 grains of radium salts ($11,651).

The imports of "vanadium steel-hardening ores" for consumption in the United States in 1919 were 6,026,005 pounds, valued at $67,846. Vanadium ore imported during the last six months of 1918 amounted to 1,772,215 pounds, valued at $5,333. No separate record was kept prior to July, 1918. For imports of ferrovanadium see under ferroalloys.

EXPORTS.

About 3 grams of elemental radium in salts is known to have been exported during 1918. There is no record of any radium exported in 1919.

No separate record is kept of vanadium exports. For exports of ferrovanadium see under ferroalloys.

ZINC.

SUPPLY.

Supplies of primary zinc in the United States, 1913–1919, in short tons.

	1913	1914	1915	1916	1917	1918	1919
Supply:							
Stock, Jan. 1:							
In bonded warehouses	48	.....	111	32	90	32	.....
At smelters	4,474	40,659	19,984	14,221	17,508	53,689	41,241
Production	346,676	353,049	489,519	668,343	669,573	517,927	465,743
Imports	6,100	880	904	684	257	35	70
Total available	357,298	394,588	510,518	683,280	687,428	571,683	507,054
Withdrawn:							
Exports, foreign, from warehouse	6,027	5,580	12,775	43,230	64,680	20,069	12,256
Exports, foreign, under drawback	7,459	4,128	32	.....	1,588	6,337	4,533
Exports, domestic	7,783	64,802	118,603	163,135	153,796	80,244	129,508
Stock, Dec. 31:							
In bonded warehouses	.....	111	32	90	32	.....	.....
At smelters	40,659	19,984	14,221	17,508	53,689	41,241	36,793
Total withdrawn	61,928	94,605	145,663	223,963	273,785	147,891	183,090
Apparent consumption	295,370	299,983	364,855	459,317	413,643	423,792	323,964

PRODUCTION.

PRIMARY ZINC.

Primary zinc produced in the United States, 1913–1919, by sources of ore, in short tons.

Source.	1913	1914	1915	1916	1917	1918	1919
United States	337,252	343,418	458,135	564,338	584,597	492,405	452,272
Foreign:							
Canada	1,424	4,538	5,103	24,376	6,787	8,700	4,007
Mexico	6,205	5,093	13,943	20,694	40,360	14,043	8,083
Europe	1,175	.....	1,073	12,379	11,689	113	.....
Africa	.....	.....	.....	2,016	.....	.....	.....
Asia	620	.....	1,030	1,905	.....	.....	.....
Australia	.....	.....	10,235	41,958	26,140	1,780	630
Other countries	.....	.....	.....	677	.....	886	751
Total foreign	9,424	9,631	31,384	104,005	84,976	25,522	13,471
Grand total	346,676	353,049	489,519	668,343	669,573	517,927	465,743

Primary zinc produced in the United States, 1913–1919, by localities in which smelted, in short tons.

Location of smelter.	1913	1914	1915	1916	1917	1918	1919
Illinois	106,654	127,946	159,958	181,433	172,489	141,844	118,458
Kansas	74,106	44,510	101,423	141,286	76,048	29,149	43,942
Oklahoma	83,214	91,367	109,208	168,206	204,394	139,066	121,988
Other States	82,702	89,226	118,930	177,418	216,642	207,868	181,355
	346,676	353,049	489,519	668,343	669,573	517,927	465,743

Primary zinc produced in the United States from domestic ores, 1910–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1910	252,479	$27,267,732	1915	458,135	$113,617,000
1911	271,621	30,964,794	1916	564,338	151,243,000
1912	323,907	44,699,166	1917	584,597	119,258,000
1913	337,252	37,772,224	1918	492,405	89,618,000
1914	343,418	35,029,000	1919	452,272	66,032,000

The following statistics of the world's production of zinc, though incomplete, show approximately the foreign production during the war. The figures in black-faced type are taken from the official statistics of the countries named; those in the ordinary type are taken from statistical handbooks, consular reports, market letters, and trade journals. There is always a possibility of duplication in figures showing European production, for some countries send crude zinc of poor quality to other countries for refining. Furthermore, secondary zinc is included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary zinc.

World's production of zinc, 1913–1919, by countries where smelted, in metric tons.

Country.	1913	1914	1915	1916	1917	1918	1919
Australia:							
Tasmania					49	3,883	3,727
Mainland	4,187	5,094	5,393	5,362	4,769	5,712	3,625
Austria	21,707	15,068	9,472	11,642	12,633	12,012	(a)
Belgium	204,220	145,925	51,660	22,930	10,290	9,245	19,860
Canada			20	2,698	9,058	11,139	11,182
China	(a)	(a)	(a)	(a)	(a)	(a)	(a)
France	67,890	42,473	19,180	20,258	22,929	18,347	10,800
Germany:							
Upper Silesia	169,439	141,761	121,851	122,489	128,832	122,961	74,023
Other Germany	113,674	94,000	65,000	55,000	57,000	53,000	(a)
Great Britain	66,243	50,000	45,000	60,000	50,000	50,000	35,000
Italy				258	367	1,188	1,282
Japan	900	5,881	21,132	38,994	54,718	40,000	20,000
Netherlands	24,323	16,453	11,130	12,101	4,059	681	
Norway	9,287	18,995	24,993	31,991	21,993	20,000	3,400
Russia	10,500	6,300	2,000	1,100	(a)	(a)	2,500
Siberia				213	569	(a)	(a)
Spain	6,003	11,733	8,117	8,523	10,155	15,900	16,314
Sweden	2,115	2,300	8,588	9,997	7,979	4,098	2,321
United States	314,498	320,279	444,082	606,307	607,423	469,853	422,513
	1,015,000	876,000	838,000	1,010,000	1,003,000	828,000	627,000

a Statistics not available.

SECONDARY ZINC.

Secondary zinc produced in the United States, 1913–1919, in short tons.

	1913	1914	1915	1916	1917	1918	1919
Secondary zinc, redistilled	25,991	20,545	29,764	28,776	16,835	9,918	19,748
Secondary zinc, remelted	24,014	22,424	23,136	21,037	14,565	17,190	20,162
Secondary zinc recovered in alloys, excluding old brass remelted	3,743	3,914	5,300	2,600	4,800	11,082	6,062

IMPORTS.

Zinc ore imported into the United States, 1918 and 1919, by countries.

Country.	1918			1919		
	Ore (short tons).	Zinc content (short tons).	Value.	Ore (short tons).	Zinc content (short tons).	Value.
Canada	14,987	5,173	$319,815	10,656	3,878	$115,974
Mexico	53,348	18,426	1,202,035	33,443	11,225	346,040
Other countries	2,567	1,210	52,119	4,550	1,906	67,646
	70,902	24,809	1,573,969	48,649	17,009	529,660

EXPORTS.

Zinc exported from the United States, 1917–1919, by classes.

Class.	1917		1918		1919	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
DOMESTIC.						
Zinc ore	2,640,960	$63,043	123,000	$2,480	.....	.....
Zinc slabs and sheets	307,592,422	38,336,559	160,487,439	17,036,378	259,016,499	$22,736,155
Zinc dross	26,604,969	2,126,909	31,631,364	2,238,913	10,245,628	739,295
Zinc manufactures	.....	570,352	.....	722,671	.....	538,133
Brass, old, for remanufacturing	8,298,989	1,758,384	4,909,717	799,318	1,321,767	176,028
Brass, bars, plates, and sheets	328,346,666	101,521,426	30,989,717	9,522,934	7,770,671	2,310,561
Brass, articles made from	.....	136,611,299	.....	19,483,146	.....	11,426,289
Cartridges	.....	42,122,656	.....	10,764,765	.....	10,346,957
FOREIGN.						
Zinc, blocks, pigs, and old	129,360,631	12,429,356	40,138,715	3,565,127	24,512,265	1,943,507
Zinc dust	158,175	21,118	79,512	10,392	217,280	25,212
Zinc manufactures	.....	50	.....	.....	.....	13,071
Zinc used in articles exported with benefit of drawback	3,176,615	[a] 106,478	12,673,361	[a] 364,080	9,065,666	[a] 278,854
	.....	335,667,630	.....	64,510,204	.....	50,534,062

[a] Declared value of the zinc used in making the articles exported with benefit of drawback.

Zinc and sheet zinc exported from the United States, 1917–1919, by destination, in short tons.

Destination.	1917		1918		1919	
	Domestic.	Foreign.	Domestic.	Foreign.	Domestic.	Foreign.
Canada	9,427	4,026	6,996	1,052	3,668	78
Great Britain	71,555	24,739	28,334	6,908	53,978	5,511
Netherlands	.....	112	.....	.....	3	.....
France	41,901	21,596	25,140	10,373	30,077	4,415
Italy	10,593	9,873	6,130	1,537	11,524	556
Russia	8,238	2,443	.....	.....	.....	.....
Japan	1,360	.....	5,287	.....	18,562	1,481
Other countries	10,722	1,891	8,357	199	11,696	205
	153,796	64,680	80,244	20,069	129,508	12,256

PRICES.

[See statement on p. 12A.]

ZINC RESIDUUM.

[See under Manganiferous zinc residuum.]

ZIRCONIUM MINERALS.

PRODUCTION.

No zirconium minerals were produced in the United States from 1912 to 1919, inclusive. The early output of zircon in Norway and in North Carolina was used in the manufacture of incandescent gas mantles. Thoria and ceria have now entirely replaced zirconia in the manufacture of such mantles. The only zirconium mineral produced in the United States is zircon, almost all of which came from North Carolina. The zirconium minerals produced and exported from Brazil consist of the silicate, zircon, and the oxide, baddeleyite.

Zirconium minerals produced, 1910–1919.[a]

Year.	United States.		Brazil.			Year.	United States.		Brazil.		
			Quantity.						Quantity.		
	Quantity (short tons).	Value.	Metric tons.	Equivalent in short tons.	Value.		Quantity (short tons).	Value.	Metric tons.	Equivalent in short tons.	Value.
1910			116	128	$23,271	1915			7	8	$2,915
1911	[b]1½	$802	41	45	16,169	1916			94	104	16,647
1912			39	43	14,772	1917			(c)	(c)	(c)
1913			1,015	1,119	54,767	1918			(c)	(c)	(c)
1914			215	237	14,903	1919			(c)	(c)	(c)

[a] In addition to the quantities and values given in this table, zircon has been produced in very small quantity in different countries, including the United States, because of its value as a gem. The actual figures of production of gem zircon are not available.
[b] The exact quantity is 3,208 pounds.
[c] Figures not yet available.

IMPORTS.

The small imports of zirconium ore were not separately reported before July 1, 1918. For the six-month period, July to December, 1918, the imports of zirconium ore entered for consumption, as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, amounted to 3,216,659 pounds (1,608 short tons), valued at $77,250, an average value of $48 a ton. In 1919 the imports amounted to 11,023 pounds, valued at $332.

EXPORTS.

Exports are negligible and are not recorded.

STATE TABLES.

Value of mineral production, 1915 to 1919, by States.[a]

State.	1915	1916	1917	1918	1919
Alabama	$29,458,157	$40,922,462	$65,024,838	$77,795,572	$65,540,376
Alaska	32,854,011	48,521,513	40,710,655	28,217,407	19,616,909
Arizona	91,552,049	192,622,991	212,615,978	203,992,915	112,550,239
Arkansas	6,558,693	9,508,001	12,061,702	14,081,691	11,249,133
California	98,198,538	137,284,754	175,399,036	201,673,547	213,823,488
Colorado	64,300,026	77,642,778	80,296,218	79,003,928	59,953,279
Connecticut	3,332,330	3,940,676	3,981,203	3,501,460	5,152,124
Delaware	282,292	336,172	523,991	372,804	390,706
District of Columbia	205,592	179,436	204,936	99,221	105,623
Florida	4,855,690	5,666,785	7,294,467	7,758,732	10,513,495
Georgia	5,094,688	6,779,828	7,650,553	8,312,051	9,429,972
Idaho	33,612,194	49,249,134	55,224,026	36,872,270	19,028,332
Illinois	114,112,315	146,359,792	234,735,962	271,244,365	213,701,212
Indiana	41,381,456	56,926,558	83,798,648	96,558,784	82,270,784
Iowa	27,048,177	30,210,284	39,336,372	38,742,009	37,882,183
Kansas	28,436,446	41,847,955	106,763,055	147,902,091	120,759,783
Kentucky	27,278,627	40,015,935	77,174,802	104,165,945	110,305,840
Louisiana	18,215,847	28,020,543	37,521,872	54,769,225	38,851,509
Maine	3,301,907	3,539,481	3,726,121	3,727,107	4,073,870
Maryland	10,581,224	13,335,013	19,617,596	20,866,706	18,345,024
Massachusetts	6,286,860	6,697,444	7,225,750	7,258,088	10,070,543
Michigan	93,938,255	140,666,124	163,997,853	158,312,121	122,973,774
Minnesota	62,391,440	113,662,522	152,490,554	155,412,823	131,529,797
Mississippi	666,143	890,566	966,135	925,192	1,628,031
Missouri	74,033,623	102,424,953	105,342,678	76,663,995	61,862,232
Montana	89,147,138	142,650,179	123,650,330	139,331,507	73,630,824
Nebraska	1,514,171	3,436,774	7,943,729	6,513,422	7,658,424
Nevada	35,991,891	53,510,559	55,408,057	51,080,169	24,457,735
New Hampshire	1,907,949	1,817,723	1,594,584	1,453,921	2,294,959
New Jersey	38,818,422	59,430,705	57,710,181	49,510,290	56,898,033
New Mexico	25,549,161	37,123,501	43,312,947	40,631,024	22,679,960
New York	36,414,038	45,619,119	52,123,552	52,768,877	56,379,564
North Carolina	3,365,805	4,595,551	5,246,391	4,973,386	6,223,953
North Dakota	985,885	1,283,809	1,749,549	1,823,109	2,413,025
Ohio	105,198,086	145,088,485	217,671,746	246,162,215	214,829,888
Oklahoma	83,672,991	169,556,331	259,134,377	336,857,921	291,078,174
Oregon	3,656,562	4,498,632	4,074,247	4,191,740	3,962,822
Pennsylvania	448,935,291	554,501,375	869,800,965	979,245,098	918,048,917
Rhode Island	855,007	789,208	717,123	760,787	853,981
South Carolina	1,129,709	1,392,073	1,393,297	1,558,543	2,370,916
South Dakota	8,093,670	8,696,680	8,348,684	7,441,981	5,842,704
Tennessee	22,166,494	28,277,365	36,910,448	39,229,614	37,134,899
Texas	29,220,951	47,711,571	75,958,481	110,306,367	190,563,015
Utah	62,586,261	99,734,209	113,433,596	105,785,474	64,165,525
Vermont	7,586,410	8,297,104	8,980,573	9,158,945	11,728,052
Virginia	16,994,786	20,560,956	32,243,648	37,639,368	36,799,407
Washington	11,455,715	14,521,014	18,576,052	20,999,691	18,267,938
West Virginia	136,070,173	187,043,011	306,916,191	327,962,620	298,018,194
Wisconsin	18,739,343	27,082,175	24,976,780	20,091,146	18,772,601
Wyoming	12,708,238	19,683,292	29,547,428	42,595,812	41,100,209

[a] In this table iron ore, not pig iron, is taken as the basis of valuation of iron, and in the case of other metals mine production (recoverable content of metals) is the basis.

Mineral production of Alabama in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	1,794	$9,976	(a)	(a)
Bauxite.....long tons..	4,928	35,035	(a)	(a)
Cement.....barrels..	1,132,963	1,719,519	(a)	(a)
Chert.....short tons..	50,000	17,500	(a)	(a)
Clay products.....	.....	2,159,104	.....	$2,781,324
Clay, raw.....short tons..	50,048	b 49,193	69,303	b 75,138
Coal.....do....	19,184,962	54,752,329	15,536,721	45,937,681
Coke.....do....	4,352,172	b 29,082,236	3,380,771	b 19,175,561
Ferroalloys.....long tons..	(a b)	(a b)	(a b)	(a b)
Fuller's earth.....short tons..	(a)	(a)	(a)	(a)
Gold.....troy ounces..	39	797	.....	.....
Graphite, crystalline.....pounds..	7,795,475	999,152	3,569,030	272,413
Iron ore.....long tons..	6,121,087	15,334,561	4,895,309	11,954,425
Iron, pig.....do....	2,645,179	b 80,893,687	2,044,937	b 53,092,133
Lime.....short tons..	49,209	439,366	135,095	1,062,542
Manganese ore.....long tons..	709	(a)	40	(a)
Manganiferous ore.....do....	443	8,424	.....	.....
Mica, sheet.....pounds..	11,800	3,150	(a)	(a)
Millstones.....	.....	.....	.....	(a)
Mineral waters.....gallons sold..	6,315	1,808	4,694	1,548
Natural gas.....M cubic feet..	4,600	1,890	.....	.....
Potash (K_2O).....short tons..	(a)	(a)	.....	.....
Pyrites.....long tons..	(a)	(a)	(a)	(a)
Sand and gravel.....short tons..	712,787	406,933	785,479	400,338
Silica (quartz).....do....	(a)	(a)	.....	.....
Silver.....troy ounces..	2	2	.....	.....
Stone.....short tons..	(c)	1,669,721	945,910	1,465,733
Miscellaneous.....	.....	5,845,181	.....	4,022,827
Total value, eliminating duplications.....	.....	77,795,572	.....	65,540,376

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Alaska in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Antimony ore.....short tons..	36	$1,500	.....	.....
Chromite.....long tons..	(a)	(a)	.....	.....
Coal.....short tons..	75,606	411,850	60,674	$343,547
Copper.....pounds..	69,224,951	17,098,563	47,220,771	8,783,063
Gold.....troy ounces..	458,641	9,480,952	455,984	9,426,032
Gypsum.....short tons..	(b)	(b)	(b)	(b)
Lead.....do....	564	80,088	687	72,822
Petroleum.....barrels..	(a)	(a)	(a)	(a)
Platinum and allied metals.....troy ounces..	(a)	(a)	569	73,663
Silver.....do....	847,789	847,789	629,708	705,273
Stone.....short tons..	(a)	(a)	(a)	(a)
Tin (metallic equivalent).....do....	68	118,000	56	73,400
Tungsten ore (60 per cent concentrates)..do....	14	22,000	.....	.....
Miscellaneous.....	.....	156,665	.....	139,109
Total value, eliminating duplications.....	.....	28,217,407	.....	19,616,909

a Value included under "Miscellaneous."
b Calcined in Washington State. Value included under "Miscellaneous."

Mineral production of Arizona in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	183	$95,789	423	$219,950
Clay products.....	.....	134,562	.....	[a] 226,034
Clay, raw.....short tons..	[b c]	[b c]	.....	.....
Copper.....pounds..	764,855,874	188,919,401	538,100,844	100,086,757
Fluorspar.....short tons..	364	5,537	[b]	[b]
Gems and precious stones.....	.....	9,206	.....	13,745
Gold.....troy ounces..	262,919	5,435,027	217,998	4,506,413
Gypsum.....short tons..	[b]	[b]	[b]	[b]
Lead.....do....	6,252	887,762	5,102	540,763
Lime.....do....	11,212	126,390	10,905	138,062
Manganese ore.....long tons..	17,612	570,005	547	14,985
Manganiferous ore.....do....	12,840	91,054	1,964	[b]
Molybdenum.....pounds..	154,923	219,010	.....	.....
Sand and gravel.....short tons..	3,722	5,920	[b]	[b]
Silica (quartz).....do....	[b]	[b]	[b]	[b]
Silver.....troy ounces..	6,686,152	6,686,152	5,266,605	5,898,598
Stone.....short tons..	[d]	278,127	566,610	399,271
Sulphuric acid [e].....do....	[e]	[e]	[b]	[b]
Tungsten ore (60 per cent concentrates)..do....	213	263,100	50	30,136
Zinc.....do....	1,135	206,538	859	125,341
Miscellaneous.....	.....	59,904	.....	350,184
Total value, eliminating duplications.....	.....	203,992,915	.....	112,550,239

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.
[e] From copper smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Arkansas in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Bauxite.....long tons..	562,892	$3,133,880	333,490	$1,855,159
Clay products.....	.....	[a] 679,183	.....	[a] 1,769,216
Coal.....short tons..	2,227,369	8,172,376	1,429,020	5,288,844
Fuller's earth.....do....	[b]	[b]	.....	.....
Gems and precious stones.....	.....	2,010	.....	[b]
Iron ore sold for magnets.....long tons..	.....	.....	[b]	[b]
Lead.....short tons..	120	17,040	28	2,968
Lime.....do....	8,320	62,250	10,794	115,019
Manganese ore.....long tons..	7,731	354,235	2,558	60,633
Manganiferous ore.....do....	9,173	93,525	564	[b]
Marl, calcareous.....short tons..	[b]	[b]	[b]	[b]
Mineral waters.....gallons sold..	863,142	70,626	1,084,373	50,360
Natural gas.....M cubic feet..	5,294,663	575,115	5,586,822	949,800
Oilstones.....short tons..	325	112,031	349	126,408
Sand and gravel.....do....	230,239	107,290	871,328	406,802
Stone.....do....	[c]	481,998	408,830	547,646
Zinc.....do....	951	173,082	189	27,594
Miscellaneous.....	.....	47,050	.....	48,684
Total value, eliminating duplications.....	.....	14,081,691	.....	11,249,133

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Figures for quantity not available for 1918.

Mineral production of California in 1918 and 1919.

Product.		1918		1919	
		Quantity.	Value.	Quantity.	Value.
Asbestos	short tons	(a)	(a)	(a)	(a)
Asphalt	do	198,535	$2,609,359	175,939	$2,958,511
Barytes	do			(a)	(a)
Borates	do	88,794	2,263,230	66,146	1,380,000
Briquets, fuel	do	(a b)	(a b)	(a b)	(a b)
Calcium chloride	do	(a)	(a)	(a)	(a)
Cement	barrels	4,238,424	7,091,789	4,743,336	8,860,196
Chromite	long tons	63,147	3,078,160	3,272	80.463
Clay products			4,329,220		5,834,648
Clay, raw	short tons	152,311	b 241,420	141,174	b 235,971
Coal	do	(a)	(a)	(a)	(a)
Copper	pounds	47,674,660	11,775,641	21,732,507	4,042,246
Diatomaceous earth	short tons	(a)	(a)	40,200	486,840
Feldspar	do	1,451	8,839	(a)	(a)
Ferroalloys	long tons	(a b)	(a b)	(a b)	(a b)
Fluorspar, optical	pounds	(a)	(a)		
Fuller's earth	short tons	(a)	(a)		
Gems and precious stones			9,572		9,221
Gold	troy ounces	799,588	16,528,953	807,667	16,695,955
Graphite, crystalline	pounds	(a)	(a)	(a)	(a)
Gypsum	short tons	(a)	(a)	(a)	(a)
Iron ore	long tons	3,121	14,683	2,053	13,796
Lead	short tons	6,686	949,415	1,784	189,118
Lime	do	55,588	558,058	39.307	466,905
Lithium minerals	do	(a)	(a)	(a)	(a)
Magnesite	do	84,077	761,811	50,020	504,973
Manganese ore	long tons	24,067	740,566	11,289	329,200
Manganiferous ore	do	68	(a)		
Marl, calcareous	short tons			(a)	(a)
Mineral waters	gallons sold	2,399,144	433,010	2,693,165	365,997
Natural gas	M cubic feet	39,718,941	7,951,666	55,607,361	9,453,300
Natural-gas gasoline	gallons	32,268,933	5,009,152	40,385,796	5,744,867
Peat	short tons	(a)	(a)	(a)	(a)
Pebbles for grinding	do	3,543	26,313	(a)	(a)
Petroleum	barrels	97,531,997	118,770,790	101,183,000	142,611,000
Platinum and allied metals	troy ounces	433	47,755	503	73,711
Potash (K_2O)	short tons	17,660	7,356,757	13,366	3,417,049
Pumice	do	(a)	(a)	(a)	(a)
Pyrites	long tons	111,861	501,541	128,803	530,678
Quicksilver	flasks	22,664	2,663,020	15,205	1,372,859
Salt	short tons	204,957	1,167,777	200,115	1,555,596
Sand and gravel	do	3,011,842	1,070,441	3,168,517	1,426,517
Sand-lime brick	thousands	(a)	(a)		
Silica (quartz)	short tons	3,544	4,489	(a)	(a)
Silver	troy ounces	1,427,711	1,427,711	1,107,189	1,240,051
Slate			(a)		
Sodium salts (carbonate, bicarbonate, and sulphate) from natural sources	short tons	19,436	974,608	21,631	592,157
Stone	do	(c)	2,564,614	2,851,820	2,798,918
Strontium ore	do	400	20,000		
Sulphuric acid d	do	(d)	(d)	(a)	(a)
Talc	do	11,864	185,775	9,837	147,470
Tungsten ore (60 per cent concentrates)	do	1,791	2,783,700	147	245,465
Zinc	do	2,781	506,087	236	34,528
Miscellaneous			1,835,448		761,407
Total value, eliminating duplications			204,673,547		213,823,488

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.
d From copper smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Colorado in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	$2,299,448	.....	$2,662,671
Clay, raw.....short tons..	98,244	b 117,934	138,706	b 139,308
Coal.....do....	12,407,571	33,404,743	10,323,420	28,748,534
Coke.....do....	989,447	b 7,450,136	613,753	b 4,383,169
Copper.....pounds..	6,277,332	1,550,501	3,560,207	662,198
Ferroalloys.....long tons..	(a b)	(a b)	5,022	b 783,767
Fluorspar.....short tons..	38,475	416,780	9,687	150,739
Gems and precious stones.....	.....	3,430	.....	1,255
Gold.....troy ounces..	616,864	12,751,718	478,266	9,886,627
Graphite, amorphous.....short tons..	(a)	(a)	(a)	(a)
Gypsum.....do....	(a)	(a)	(a)	(a)
Iron ore.....long tons..	7,850	(a)	4,278	(a)
Iron, pig.....do....	365,395	(a b)	(a b)	(a b)
Lead.....short tons..	32,980	4,683,214	18,535	1,964,722
Lime.....do....	6,077	61,476	2,136	26,102
Manganese ore.....long tons..	4,821	180,246	11,166	238,671
Manganiferous ore.....do....	124,068	586,111	40,840	166,075
Mica:				
Scrap.....short tons..	38	1,020	(a)	(a)
Sheet.....pounds..	(c)		.....	.....
Mineral paints, zinc, and lead pigments .....short tons..	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	319,542	81,367	391,851	81,087
Molybdenum.....pounds..	663,386	995,695	296,813	340,444
Natural gas.....M cubic feet..	10,103	2,575	10,170	1,900
Natural-gas gasoline.....gallons..	2,475	620	.....	.....
Petroleum.....barrels..	143,286	188,472	121,000	183,000
Potash (K_2O).....short tons..	(a)	(a)	1,678	540,646
Pyrites.....long tons..	18,817	115,712	17,474	85,261
Sand and gravel.....short tons..	172,472	90,657	248,483	154,978
Silica (quartz).....do....	(a)	(a)	(a)	(a)
Silver.....troy ounces..	7,063,554	7,063,554	5,758,010	6,448,971
Stone.....short tons..	(d)	771,472	529,800	723,430
Sulphur.....long tons..	(a)	(a)	.....	.....
Tungsten ore (60 per cent concentrates) .....short tons..	1,910	2,595,800	130	78,334
Uranium and vanadium ores.....	.....	880,328	.....	1,575,073
Zinc.....short tons..	44,567	8,111,185	18,610	2,717,096
Miscellaneous.....	.....	14,035,490	.....	9,507,210
Total value, eliminating duplications.....	.....	79,003,928	.....	59,953,279

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Survey not at liberty to publish quantity.
d Figures for quantity not available for 1918.

Mineral production of Connecticut in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	$1,627,508	.....	$2,552,070
Clay, raw.....short tons..	(a b)	(a b)	.....	.....
Diatomaceous earth.....do....	(a)	(a)	(a)	(a)
Feldspar.....do....	5,942	52,117	10,880	133,113
Iron ore.....long tons..	12,130	(a)	5,384	(a)
Iron, pig.....do....	7,088	(a b)	3,500	(a b)
Lime.....short tons..	(a)	(a)	(a)	(a)
Mineral waters.....gallons sold..	1,364,443	72,527	1,216,184	61,150
Peat.....short tons..	(a)	(a)	.....	.....
Sand and gravel.....do....	140,383	99,233	261,815	212,286
Silica (quartz).....do....	(a)	(a)	(a)	(a)
Stone.....do....	(c)	1,025,475	1,288,650	1,505,748
Miscellaneous.....	.....	1,014,546	.....	880,128
Total value, eliminating duplications.....	.....	3,501,460	.....	5,152,124

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Delaware in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products		$164,486		$223,035
Clay, raw, short tons	9,039	[a] 62,981	8,058	[a] 69,539
Mineral waters, gallons sold	[b]	[b]		
Sand and gravel, short tons	103,299	76,822	34,843	19,404
Stone, do	[c]	[b]	88,730	148,267
Miscellaneous		131,496		
Total value, eliminating duplications		372,804		390,706

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."
[c] Figures for quantity not available for 1918.

Mineral production of the District of Columbia in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products		$66,606		[a] $61,394
Ferroalloys, long tons			[b c]	[b c]
Mineral waters, gallons sold	[b]	[b]	[b]	[b]
Sand-lime brick, thousands	[b]	[b]	[b]	[b]
Stone, short tons	[d]	7,585	5,700	15,627
Miscellaneous		25,030		133,102
Total value, eliminating duplications		99,221		105,623

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.

Mineral production of Florida in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products		[a] $181,339		[a] $185,135
Clay, raw, short tons	[b c]	[b c]	[b c]	[b c]
Fuller's earth, do	[b]	[b]	[b]	[b]
Gems and precious stones		[b]		
Ilmenite, short tons	1,200	7,500	[b]	[b]
Lime, do	[b]	[b]	[b]	[b]
Mineral waters, gallons sold	164,630	12,883	192,935	12,062
Peat, short tons	[b]	[b]	[b]	[b]
Phosphate rock, long tons	2,067,230	6,090,106	1,660,200	7,797,929
Sand and gravel, short tons	158,489	48,768	271,794	164,101
Sand-lime brick, thousands	[b]	[b]	[b]	[b]
Stone, short tons	[d]	304,807	129,030	185,531
Miscellaneous		1,358,862		2,488,573
Total value, eliminating duplications		7,758,732		10,513,495

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.

Mineral production of Georgia in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	(a)	(a)
Barytes.....do....	69,318	$418,178	85,303	$667,521
Bauxite.....long tons..	35,637	265,491	37,201	307,573
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	2,964,706	.....	3,796,160
Clay, raw.....short tons..	140,675	b 641,283	95,587	b 703,639
Coal.....do....	66,716	239,377	53,337	198,033
Coke.....do....	22,048	b 193,317	18,149	b 149,022
Copper.....pounds..	397,078	98,078	8,306	1,545
Fuller's earth.....short tons..	(a)	(a)	(a)	(a)
Gold.....troy ounces..	285	5,893	37	767
Iron ore:				
Sold to furnaces.....long tons..	262,003	878,612	74,007	294,619
Sold for paint.....do....	3,229	(a)	.....	.....
Iron, pig.....do....	720	(a b)	.....	.....
Manganese ore.....do....	6,679	284,615	48	(a)
Manganiferous ore.....do....	10,776	61,682	3,726	(a)
Mica:				
Scrap.....short tons..	40	2,750	51	778
Sheet.....pounds..	208,200	77,300	47,018	19,682
Mineral waters.....gallons sold..	314,388	27,810	364,310	39,282
Peat.....short tons..	(a)	(a)	.....	.....
Potash (K_2O).....do....	.....	.....	(a)	(a)
Pyrites.....long tons..	31,315	268,797	34,412	349,779
Sand and gravel.....short tons..	270,071	121,655	362,487	181,844
Sand-lime brick.....thousands..	(a)	(a)	(a)	(a)
Silver.....troy ounces..	25	25	8	9
Stone.....short tons..	(c)	1,903,255	380,020	2,741,616
Talc.....do....	(a)	(a)	(a)	(a)
Miscellaneous.....	.....	721,827	.....	830,764
Total value, eliminating duplications.....	.....	8,312,051	.....	9,429,972

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Idaho in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Antimony ore.....short tons..	(a)	(a)	.....	.....
Clay products.....	.....	(a)	.....	$283,492
Clay, raw.....short tons..	(a b)	(a b)	(a b)	(a b)
Coal.....do....	(a)	(a)	(a)	(a)
Cobalt concentrates.....do....	55	(a)	.....	.....
Copper.....pounds..	6,533,888	$1,613,870	3,122,763	580,834
Diatomaceous earth.....short tons..	(a)	(a)	(a)	(a)
Gems and precious stones.....	.....	(c)	.....	.....
Gold.....troy ounces..	33,999	702,816	34,503	713,238
Iron ore.....long tons..	785	(a)	221	(a)
Lead.....short tons..	147,348	20,923,416	91,171	9,664,121
Lime.....do....	(a)	(a)	(a)	(a)
Phosphate rock.....long tons..	(a)	(a)	(a)	(a)
Quicksilver.....flasks..	22	2,585	.....	.....
Salt.....short tons..	(a)	(a)	39	530
Sand and gravel.....do....	(a)	(a)	(a)	(a)
Sand-lime brick.....thousands..	(a)	(a)	(a)	(a)
Silver.....troy ounces..	9,172,340	9,172,340	5,579,056	6,248,543
Stone.....short tons..	(c)	68,367	112,510	248,789
Zinc.....do....	22,581	4,109,716	7,997	1,167,579
Miscellaneous.....	.....	279,685	.....	125,289
Total value, eliminating duplications.....	.....	36,872,270	.....	19,028,332

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Illinois in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	100,952	$1,315,001	93,788	$1,138,759
Barytes.....do....	.....	.....	(a)	(a)
Cement.....barrels..	[b] 3,703,471	[b] 5,695,186	[b] 4,873,831	[b] 7,901,689
Clay products.....	.....	12,459,777	.....	17,408,022
Clay, raw.....short tons..	169,182	[c] 413,901	139,458	[c] 302,306
Coal.....do....	89,291,105	206,860,291	60,862,608	140,075,969
Coke.....do....	2,285,610	[c] 18,625,436	1,703,903	[c] 13,206,405
Ferroalloys.....long tons..	(a c)	(a c)	(a c)	(a c)
Fluorspar.....short tons..	132,798	2,887,099	92,729	2,430,361
Iron, pig.....long tons..	3,409,876	[c] 105,415,030	2,532,341	[c] 61,829,286
Lead.....short tons..	2,273	322,766	2,105	223,130
Lime.....do....	64,672	535,090	65,060	580,041
Mineral paints, zinc and lead pigments...do....	(a c)	(a c)	(a c)	(a c)
Mineral waters.....gallons sold..	921,953	43,448	364,934	21,151
Natural gas.....M cubic feet..	4,473,018	620,949	3,824,666	612,000
Natural-gas gasoline.....gallons..	4,574,565	890,436	6,059,828	1,115,083
Peat.....short tons..	(a)	(a)	(a)	(a)
Petroleum.....barrels..	13,365,974	31,230,000	11,960,000	29,720,000
Potash (K_2O).....short tons..	.....	.....	(a)	(a)
Pyrites.....long tons..	24,369	85,659	13,353	46,634
Sand and gravel.....short tons..	6,355,406	3,980,124	7,093,333	4,252,094
Sand and sandstone (finely ground).....do....	(a)	(a)	43,067	255,250
Silver.....troy ounces..	8,171	8,171	4,440	4,973
Stone.....short tons..	(d)	2,990,150	5,035,770	3,790,133
Sulphuric acid (60° Baumé) [e].....do....	(e)	(e)	[e] 249,943	[e] 2,691,900
Tripoli.....do....	12,004	100,126	13,014	116,492
Zinc.....do....	3,792	690,144	6,788	991,048
Miscellaneous.....	.....	6,669,347	.....	3,956,522
Total value, eliminating duplications.....	.....	271,244,365	.....	213,701,212

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.
[e] From zinc smelting. No canvass for 1918. According to Bureau of the Census for 1919. Figures represent production, the value having been partly estimated by Geological Survey to cover acid consumed by producer as well as that sold.

Mineral production of Indiana in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	[a] 6,205,326	[a] $9,580,563	[a] 7,667,976	[a] $12,527,770
Clay products.....	.....	7,950,926	.....	11,634,097
Clay, raw.....short tons..	104,396	[b] 131,324	76,906	[b] 80,267
Coal.....do....	30,678,634	70,384,601	20,912,288	46,345,750
Coke.....do....	3,898,215	[b] 31,462,493	3,702,180	[b] 27,543,179
Iron, pig.....long tons..	2,583,375	[b] 75,149,991	2,287,068	[b] 51,474,116
Lime.....short tons..	116,321	865,597	107,460	902,469
Mineral paints, zinc and lead pigments...do....	.....	.....	(b c)	(b c)
Mineral waters.....gallons sold..	555,076	179,431	538,294	181,495
Natural gas.....M cubic feet..	1,666,822	899,671	1,406,949	534,600
Natural-gas gasoline.....gallons..	.....	.....	1,800	357
Oilstones.....short tons..	220	27,609	447	44,822
Peat.....do....	(c)	(c)	(c)	(c)
Petroleum.....barrels..	877,558	2,028,129	972,000	2,284,000
Potash (K_2O).....short tons..	(c)	(c)	(c)	(c)
Sand and gravel.....do....	4,785,615	1,719,417	6,187,741	2,680,968
Sand-lime brick.....thousands..	7,903	62,633	11,738	108,089
Stone.....short tons..	(d)	2,819,083	1,645,450	4,953,903
Miscellaneous.....	.....	41,124	.....	143,017
Total value, eliminating duplications.....	.....	96,558,784	.....	82,270,784

[a] Exclusive of natural cement, value for which is included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] Figures for quantity not available for 1918.

Mineral production of Iowa in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	3,188,669	$5,423,926	4,569,110	$7,798,347
Clay products.....	.....	[a] 5,313,394	.....	[a] 8,107,601
Clay, raw.....short tons..	5,416	[b] 3,705	8,506	[b] 5,600
Coal.....do....	8,192,195	24,703,237	5,624,692	17,352,620
Ferroalloys.....long tons..	[b c]	[b c]	[b c]	[b c]
Gypsum.....short tons..	327,927	1,946,414	421,279	2,634,444
Lime.....do....	[c]	[c]	[c]	[c]
Mineral waters.....gallons sold..	87,703	3,937	39,661	5,703
Natural gas.....M cubic feet..	1,758	245	740	200
Potash (K_2O).....short tons..	.....	.....	89	20,025
Sand and gravel.....do....	2,004,444	904,307	2,093,471	1,383,764
Stone.....do....	[d]	379,029	513,030	508,606
Miscellaneous.....	.....	1,187,938	.....	540,173
Total value, eliminating duplications.....	.....	38,742,009	.....	37,882,183

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] Figures for quantity not available for 1918.

Mineral production of Kansas in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	[a]	[a]	[a]	[a]
Cement.....barrels..	[b] 2,586,834	[b] $4,219,203	[b] 3,023,901	[b] $5,467,284
Clay products.....	.....	2,064,520	.....	3,426,002
Coal.....short tons..	7,561,947	22,028,142	5,224,724	15,917,053
Gypsum.....do....	54,958	343,749	78,479	520,673
Lead.....do....	7,252	1,029,784	11,283	1,195,998
Lime.....do....	[a]	[a]	[a]	[a]
Mineral paints, zinc and lead pigments...do....	[a c]	[a c]	[a c]	[a c]
Mineral waters.....gallons sold..	403,862	75,359	394,625	69,482
Natural gas.....M cubic feet..	27,824,641	6,640,781	14,771,733	3,397,500
Natural-gas gasoline.....gallons..	2,389,856	593,730	3,283,850	620,876
Petroleum.....barrels..	45,451,017	100,546,202	33,048,000	77,026,000
Pumice.....short tons..	[a]	[a]	[a]	[a]
Salt.....do....	819,504	3,598,289	773,576	4,497,247
Sand and gravel.....do....	761,110	264,073	954,121	507,642
Stone.....do....	[d]	561,382	680,400	860,851
Zinc.....do....	30,197	5,495,854	47,636	6,954,856
Miscellaneous.....	.....	1,714,262	.....	1,483,061
Total value, eliminating duplications.....	.....	147,902,091	.....	120,759,783

[a] Value included under "Miscellaneous."
[b] Exclusive of natural cement, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.

Mineral production of Kentucky in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	(a)	(a)
Barytes.....do....	(a)	(a)	5,435	$36,408
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	$6,172,554	.....	5,711,257
Clay, raw.....short tons..	91,367	[b] 327,317	52,690	[b] 223,550
Coal.....do....	31,612,617	80,666,842	30,036,061	73,891,049
Coke.....do....	818,785	[b] 4,455,995	691,969	[b] 3,901,481
Fluorspar.....do....	[c] 87,604	[c] 2,069,185	32,386	883,171
Iron, pig.....long tons..	234,952	[b] 8,031,994	149,951	[b] 4,508,129
Lead.....short tons..	185	26,270	86	9,116
Lime.....do....	1,884	14,925	988	9,275
Lithographic stone.....do....	3	350	.....	.....
Mineral waters.....gallons sold..	255,852	41,997	213,436	37,876
Natural gas.....M cubic feet..	3,022,439	665,843	2,057,003	699,400
Natural-gas gasoline.....gallons..	3,330,986	660,108	5,136,326	1,144,746
Oilstones.....short tons..	(a)	(a)	(a)	(a)
Petroleum.....barrels..	4,367,968	11,287,162	9,278,000	24,597,000
Phosphate rock.....long tons..	(a)	(a)	(a)	(a)
Pyrites.....do....	(a)	(a)	.....	.....
Sand and gravel.....short tons..	818,471	557,548	1,151,297	744,073
Stone.....do....	[d]	970,494	1,215,330	1,447,352
Zinc.....do....	315	57,330	36	5,256
Miscellaneous.....	.....	975,337	.....	1,089,861
Total value, eliminating duplications.....	.....	104,165,945	.....	110,305,840

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Exclusive of optical fluorspar, value for which is included under "Miscellaneous."
[d] Figures for quantity not available for 1918.

Mineral production of Louisiana in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	(a)	(a)
Clay products.....	.....	$458,445	.....	[b] $759,386
Mineral waters.....gallons sold..	(a)	(a)	(a)	(a)
Natural gas.....M cubic feet..	36,094,132	4,912,235	47,061,891	2,823,700
Natural-gas gasoline.....gallons..	7,020,538	1,178,651	10,063,025	1,667,275
Petroleum.....barrels..	16,042,600	27,535,060	17,188,000	26,803,000
Potash (K_2O).....short tons..	487	188,439	.....	.....
Salt.....do....	(a)	(a)	(a)	(a)
Sand and gravel.....do....	1,024,498	595,682	772,943	605,401
Sand-lime brick.....thousands..	(a)	(a)	(a)	(a)
Stone.....short tons..	(a)	(a)	(a)	(a)
Sulphur.....long tons..	(a)	(a)	(a)	(a)
Miscellaneous.....	.....	19,900,713	.....	6,192,747
Total value, eliminating duplications.....	.....	54,769,225	.....	38,851,509

[a] Value included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."

Mineral production of Maine in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products		$500,725		$612,562
Copper.....pounds..	766,000	189,202	376,186	69,971
Feldspar.....short tons..	25,376	283,957	14,387	206,659
Gems and precious stones		7,132		16,225
Gold.....troy ounces..	33	682	7	145
Lead.....short tons..			1	106
Lime.....do....	83,034	906,179	96,582	1,207,508
Magnesium.....pounds..	(a b)	(a b)	(c)	(c)
Mineral waters.....gallons sold..	829,338	266,168	728,606	309,460
Peat.....short tons..	(a)	(a)		
Potash (K_2O).....do....	(a)	(a)		
Sand and gravel.....do....	35,623	31,421	46,296	39,319
Silica (quartz).....do....	(a)	(a)	(a)	(a)
Silver.....troy ounces..	6,338	6,338	4,142	4,639
Slate		287,891		279,274
Stone.....short tons..	(d)	1,212,643	173,050	1,327,330
Miscellaneous		372,073		672
Total value, eliminating duplications		3,727,107		4,073,870

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures included with New York. Not separable.
d Figures for quantity not available for 1918.

Mineral production of Maryland in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)	(a)	(a)
Cement.....barrels..	(a)	(a)	(a)	(a)
Chromite.....long tons..	(a)	(a)	69	$3,467
Clay products		$2,721,115		2,734,141
Clay, raw.....short tons..	23,254	b 65,387	20,650	b57,516
Coal.....do....	4,497,297	12,466,189	3,021,686	8,255,984
Coke.....do....	474,368	(a b)	356,237	(a b)
Feldspar.....do....	8,784	40,299	7,820	39,610
Ferroalloys.....long tons..	(a b)	(a b)	(a b)	(a b)
Iron ore:				
Sold to furnaces.....do....	6,070	23,686	1,501	(a)
Sold for paint.....do....			(a)	(a)
Iron, pig.....do....	370,993	(a b)	(a b)	(a b)
Lime.....short tons..	106,737	808,766	103,563	860,187
Millstones		(a)		
Mineral paints, zinc and lead pigments .....short tons..	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	1,089,966	100,575	1,077,253	105,397
Natural gas.....M cubic feet..	(a)	(a)	167	60
Potash (K_2O).....short tons..	(a)	(a)	(a)	(a)
Sand and gravel.....do....	1,759,419	1,303,780	1,747,587	1,800,882
Silica (quartz).....do....	9,015	47,796	7,909	88,713
Slate		42,113		71,593
Stone.....short tons..	(c)	921,199	871,750	1,331,710
Talc.....do....	(a)	(a)	(a)	(a)
Miscellaneous		20,619,278		11,958,766
Total value, eliminating duplications		20,866,706		18,345,024

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Massachusetts in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products		$1,493,765		$2,254,150
Clay, raw, short tons	2,176	a6,373	(a b)	(a b)
Coke, do	556,397	(a b)	393,331	(a b)
Fuller's earth, do	(b)	(b)	(b)	(b)
Iron ore, long tons	10,228	(b)	6,852	(b)
Iron, pig, do	4,467	(a b)	(a b)	(a b)
Lime, short tons	123,697	1,030,929	131,762	1,339,464
Mineral waters, gallons sold	1,999,592	125,208	1,630,216	112,213
Peat, short tons	18,500	160,200	(b)	(b)
Potash (K_2O), do	(b)	(b)	1	453
Sand and gravel, do	1,170,562	1,133,884	1,381,555	1,839,435
Sand-lime brick, thousands	6,851	55,440	(b)	(b)
Silica (quartz), short tons	4,506	15,104	(b)	(b)
Stone, do	(c)	3,069,461	1,370,830	4,363,813
Talc, do	(b)	(b)	(b)	(b)
Miscellaneous		6,169,606		3,443,998
Total value, eliminating duplications		7,258,088		10,070,543

a Value not included in total value for State.
b Value included under "Miscellaneous."
c Figures for quantity not available for 1918.

Mineral production of Michigan in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Bromine, pounds	1,605,696	$855,841	1,736,633	$1,179,834
Calcium chloride, short tons	20,615	394,200	21,668	256,091
Cement, barrels	3,618,088	6,078,167	4,990,308	8,468,196
Clay products		3,685,172		5,796,803
Clay, raw, short tons	2,359	a 6,373	568	a 2,123
Coal, do	1,464,818	5,615,097	996,545	3,864,228
Coke, do	(a b)	(a b)	808,729	a 6,204,747
Copper, pounds	226,794,139	56,018,152	178,826,486	33,261,726
Gems and precious stones		364		277
Grindstones, short tons	(b)	(b)	(b)	(b)
Gypsum, do	286,768	1,761,149	339,125	2,390,367
Iron ore:				
Sold to furnaces, long tons	17,587,416	65,900,501	12,911,727	49,774,212
Sold for paint, do	101	(b)	481	(b)
Iron, pig, do	502,884	a 17,823,684	416,277	a 13,418,185
Lime, short tons	134,813	1,186,007	145,783	1,381,534
Magnesium, pounds	(b)	(b)	(b)	(b)
Manganiferous ore, long tons	22,673	(b)	29,296	(b)
Mineral waters, gallons sold	1,216,882	129,592	1,570,906	132,312
Natural gas, M cubic feet	1,173	1,045	1,098	809
Petroleum, barrels	(b)	(b)	(b)	(b)
Potash (K_2O), short tons	369	188,390	149	48,581
Salt, do	2,403,125	9,048,650	2,492,378	9,456,138
Sand and gravel, do	2,837,371	1,239,874	3,772,535	1,944,143
Sand-lime brick, thousands	22,564	198,633	42,063	507,010
Scythestones, short tons	(b)	(b)		
Silica (quartz), do	(b)	(b)	(b)	(b)
Silver, troy ounces	509,467	509,467	441,430	494,402
Stone, short tons	(c)	5,264,432	7,222,200	3,859,930
Miscellaneous		8,492,319		157,190
Total value, eliminating duplications		158,312,121		122,973,774

a Value not included in total value for State.
b Value included under "Miscellaneous."
c Figures for quantity not available for 1918.

Mineral production of Minnesota in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	1,181,529	$1,789,561	1,632,374	$2,489,518
Clay products.....	.....	[a] 1,503,659	.....	[a] 2,287,906
Clay, raw.....short tons..	[b c]	[b c]	22,907	[c] 35,827
Coke.....do....	784,065	[c] 6,806,468	586,094	[c] 3,969,068
Flint lining for tube mills.....do....	1,200	21,600	[b]	[b]
Gems and precious stones.....	.....	[b]	.....	.....
Iron ore.....long tons..	43,263,240	144,706,532	34,547,356	121,107,247
Iron, pig.....do....	386,775	[b c]	[b c]	[b c]
Lime.....short tons..	10,792	86,882	23,005	294,313
Manganiferous ore.....long tons..	860,696	4,242,857	245,883	885,996
Mineral waters.....gallons sold..	2,248,731	99,159	2,731,967	113,776
Pebbles for grinding.....short tons..	[b]	[b]	[b]	[b]
Sand and gravel.....do....	1,150,660	492,232	1,304,395	905,341
Sand-lime brick.....thousands..	12,255	90,212	23,391	239,676
Stone.....short tons..	[d]	1,710,267	462,040	2,345,162
Miscellaneous.....	.....	11,968,964	.....	8,694,172
Total value, eliminating duplications.....	.....	155,412,823	.....	131,529,797

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.

Mineral production of Mississippi in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	$528,481	.....	$951,161
Clay, raw.....short tons..	4,066	[a] 28,027	2,560	[a] 10,780
Mineral waters.....gallons sold..	175,533	47,539	124,788	29,126
Sand and gravel.....short tons..	1,199,515	346,653	1,624,538	645,795
Stone.....do....	[b]	[b]	[b]	[b]
Miscellaneous.....	.....	2,519	.....	1,949
Total value, eliminating duplications.....	.....	925,192	.....	1,628,031

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."

Mineral production of Missouri in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	49,094	$393,738	73,247	$640,398
Briquets, fuel.....do....	(a b)	(a b)	(a b)	(a b)
Cement.....barrels..	4,515,695	7,132,470	5,496,164	9,264,017
Chats.....short tons..	902,129	c 270,000	1,375,757	c 550,300
Clay products.....	.....	9,155,088	.....	10,997,949
Clay, raw.....short tons..	464,446	b 1,192,996	341,385	b 1,004,033
Coal.....do....	5,667,730	17,126,498	3,979,798	12,766,366
Cobalt.....do....	(d)	(d)	28	122,452
Coke.....do....	(a b)	(a b)	(a b)	(a b)
Copper.....pounds..	577,665	142,683	1,617,200	300,799
Iron ore.....long tons..	71,968	270,337	53,626	223,144
Iron, pig.....do....	83,432	b 3,084,136	49,383	b 1,649,271
Lead.....short tons..	194,175	27,572,850	163,290	17,308,740
Lime.....do....	201,737	1,721,800	180,749	1,735,705
Mineral paints, zinc and lead pigments..do....	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	306,299	38,478	212,871	39,641
Natural gas.....M cubic feet..	22,120	5,548	4,606	3,000
Nickel.....short tons..	.....	.....	130	85,118
Petroleum.....barrels..	.....	.....	(a)	(a)
Potash (K_2O).....short tons..	(a)	(a)	(a)	(a)
Pyrites.....long tons..	7,674	69,202	(a)	(a)
Sand and gravel.....short tons..	1,743,616	772,753	1,665,295	873,333
Silver.....troy ounces..	46,939	46,939	90,401	101,249
Stone.....short tons..	(e)	1,668,789	1,146,040	2,190,884
Tripoli.....do....	f 6,778	f 81,728	2,950	8,926
Zinc.....do....	55,992	10,190,544	31,540	4,640,840
Miscellaneous.....	.....	3,355,173	.....	2,988,345
Total value, eliminating duplications.....	.....	76,663,995	.....	61,862,232

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Estimated.
d Small production. Figures not available.
e Figures for quantity not available for 1918.
f Includes production from Oklahoma. Not separable.

Mineral production of Montana in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	$464,715	.....	$394,899
Clay, raw.....short tons..	9,418	b 24,503	5,077	b 30,551
Coal.....do....	4,532,505	11,444,875	3,236,369	8,644,344
Copper.....pounds..	323,174,850	79,824,188	169,981,288	31,616,520
Ferroalloys.....long tons..	(a b)	(a b)	(a b)	(a b)
Gems and precious stones.....	.....	47,753	.....	48,391
Gold.....troy ounces..	150,193	3,104,764	107,856	2,229,588
Graphite, crystalline.....pounds..	(a)	(a)	.....	.....
Gypsum.....short tons..	(a)	(a)	(a)	(a)
Iron ore.....long tons..	1,415	(a)	3,438	(a)
Lead.....short tons..	18,568	2,636,647	17,219	1,825,201
Lime.....do....	(a)	(a)	3,340	35,834
Manganese ore.....long tons..	199,932	4,623,378	24,993	993,633
Mineral waters.....gallons sold..	193,557	8,912	499,225	6,811
Natural gas.....M cubic feet..	177,039	62,148	857,958	85,800
Petroleum.....barrels..	69,323	125,828	90,000	171,000
Potash (K_2O).....short tons..	(a)	(a)	.....	.....
Sand and gravel.....do....	348,347	74,474	159,564	71,736
Silica (quartz).....do....	.....	.....	(a)	(a)
Silver.....troy ounces..	16,797,479	16,797,479	12,541,181	14,046,123
Stone.....short tons..	(c)	282,228	209,140	183,703
Tungsten ore (60 per cent concentrates)...do....	22	31,800	.....	.....
Zinc.....do....	104,629	19,042,491	84,382	12,319,759
Miscellaneous.....	.....	787,627	.....	1,030,066
Total value, eliminating duplications.....	.....	139,331,507	.....	73,630,824

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Nebraska in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Cement.....barrels..	.....	.....	(a)	(a)
Clay products.....	.....	[b] $789,612	.....	[b] $1,038,668
Clay, raw.....short tons..	1,351	[c] 2,463	(a c)	(a c)
Gems and precious stones.....	.....	(a)	.....	.....
Mineral paints, zinc and lead pigments .....short tons..	(a c)	(a c)	(a c)	(a c)
Mineral waters.....gallons sold..	1,080	155	(a)	(a)
Potash (K_2O).....short tons..	14,011	5,098,023	24,557	5,449,275
Pumice.....do....	(a)	(a)	(a)	(a)
Sand and gravel.....do....	975,318	278,638	1,211,395	556,080
Sodium carbonate from natural sources...do....	(a)	(a)	.....	.....
Stone.....do....	(d)	315,200	203,550	280,662
Miscellaneous.....	.....	77,576	.....	344,337
Total value, eliminating duplications.....	.....	6,513,422	.....	7,658,424

[a] Value included under "Miscellaneous."
[b] Exclusive of pottery, value for which is included under "Miscellaneous."
[c] Value not included in total value for State.
[d] Figures for quantity not available for 1918.

Mineral production of Nevada in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Antimony ore.....short tons..	95	(a)	.....	.....
Barytes.....do....	(a)	(a)	(a)	(a)
Clay products.....	.....	(a)	.....	(a)
Clay, raw.....short tons..	180	[b] $1,805	(a b)	(a b)
Copper.....pounds..	116,316,441	28,730,161	52,331,175	$9,733,599
Diatomaceous earth.....short tons..	(a)	(a)	(a)	(a)
Fluorspar.....do....	.....	.....	(a)	(a)
Fuller's earth.....do....	(a)	(a)	.....	.....
Gems and precious stones.....	.....	21,674	.....	13,679
Gold.....troy ounces..	320,239	6,619,937	219,695	4,541,502
Graphite, amorphous.....short tons..	(a)	(a)	(a)	(a)
Gypsum.....do....	(a)	(a)	91,756	497,561
Iron ore.....long tons..	20,303	(a)	.....	.....
Lead.....short tons..	11,658	1,655,474	7,675	813,517
Lime.....do....	(a)	(a)	(a)	(a)
Manganese ore.....long tons..	19,872	544,727	425	(a)
Manganiferous ore.....do....	80,354	112,014	85,110	200,799
Mineral waters.....gallons sold..	(a)	(a)	(a)	(a)
Pebbles for grinding.....short tons..	(a)	(a)	(a)	(a)
Platinum and allied metals.....troy ounces..	(a)	(a)	(a)	(a)
Potash (K_2O).....short tons..	(a)	(a)	.....	.....
Quicksilver.....flasks..	1,044	122,670	756	68,259
Salt.....short tons..	970	4,175	(a)	(a)
Sand and gravel.....do....	25,325	3,943	70,569	7,011
Silver.....troy ounces..	10,000,599	10,000,599	6,863,580	7,687,210
Stone.....short tons..	(c)	95,821	53,720	88,566
Sulphur.....long tons..	(a)	(a)	(a)	(a)
Tungsten ore (60 per cent concentrates) .....short tons..	898	1,091,900	.....	.....
Uranium and vanadium ores.....	.....	3,448	.....	.....
Zinc.....short tons..	8,362	1,521,953	4,502	657,343
Miscellaneous.....	.....	551,673	.....	149,235
Total value, eliminating duplications.....	.....	51,080,169	.....	24,457,735

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Figures for quantity not available for 1918.

Mineral production of New Hampshire in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products		[a] $235,219		[a] $608,155
Fluorspar, short tons	[b]	[b]	[b]	[b]
Garnet, abrasive, do	[b]	[b]	[b]	[b]
Gems and precious stones		[b]		[b]
Lead, short tons	30	4,260		
Mica:				
Scrap, do	530	7,040	738	13,356
Sheet, pounds	376,900	106,200	235,724	90,915
Mineral waters, gallons sold	182,326	8,256	197,012	8,941
Peat, short tons	[b]	[b]	[b]	[b]
Sand and gravel, do	123,743	17,003	333,073	70,174
Scythestones, do	[b]	[b]	[b]	[b]
Silver, troy ounces	1,200	1,200		
Stone, short tons	[c]	1,013,526	104,690	1,443,204
Zinc, do	14	2,548		
Miscellaneous		58,669		60,214
Total value, eliminating duplications		1,453,921		2,294,959

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value included under "Miscellaneous."
[c] Figures for quantity not available for 1918.

Mineral production of New Jersey in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel, short tons	[a b]	[a b]	[a b]	[a b]
Cement, barrels	[a]	[a]	[a]	[a]
Clay products		$20,741,244		$26,545,959
Clay, raw, short tons	286,474	[b] 1,068,572	278,190	[b] 1,078,482
Coke, do	682,148	[a b]	788,465	[a b]
Ferroalloys, long tons	[a b]	[a b]	[a b]	[a b]
Gems and precious stones		[a]		
Iron ore, long tons	375,238	1,945,651	336,629	1,712,255
Iron, pig, do	222,418	[b] 7,611,885	111,362	[b] 3,505,635
Lime, short tons	2,208	12,268	4,828	29,098
Manganese ore, long tons	64	[a]		
Manganiferous residuum [c], do	146,796	[a]	80,418	[a]
Marl, greensand, short tons	3,582	4,775	[a]	[a]
Mineral paints, zinc and lead pigments, do	[a b]	[a b]	[a b]	[a b]
Mineral waters, gallons sold	1,134,848	110,150	1,244,983	143,303
Peat, short tons	26,218	264,822	27,743	267,567
Sand and gravel, do	3,579,862	2,462,864	3,710,226	2,576,272
Sand and sandstone (finely ground), do	[a]	[a]		
Slate		[a]		
Stone, short tons	[d]	2,210,407	1,625,870	2,521,860
Sulphuric acid [e], do	[e]	[e]	[a]	[a]
Talc, do	[a]	[a]		
Zinc, do	98,470	[a]	92,912	[a]
Miscellaneous		29,186,069		28,798,876
Total value, eliminating duplications		49,510,290		56,898,033

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Ore mined in New Jersey; smelted in Pennsylvania.
[d] Figures for quantity not available for 1918.
[e] From copper smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of New Mexico in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)		
Clay products.....		$194,533		$235,118
Clay, raw.....short tons..	4,213	b 13,488	1,609	b 7,504
Coal.....do....	4,023,239	10,787,082	3,138,756	9,750,833
Coke.....do....	597,072	b 3,729,312	260,162	b 1,777,769
Copper.....pounds..	98,264,563	24,271,347	51,150,541	9,514,000
Fluorspar.....short tons..	3,437	64,348	2,346	37,643
Gems and precious stones.....		1,079		(a)
Gold.....troy ounces..	33,030	682,791	31,717	655,656
Gypsum.....short tons..	(a)	(a)	(a)	(a)
Iron ore.....long tons..	275,266	546,212	224,553	506,538
Lead.....short tons..	4,199	596,275	1,443	152,985
Lime.....do....	(a)	(a)	1,758	17,615
Manganese ore.....long tons..	3,126	80,195		
Manganiferous ore.....do....	33,307	159,890	16,520	75,367
Mica:				
Scrap.....short tons..	(a)	(a)	(a)	(a)
Sheet.....pounds..	(a)	(a)	(a)	(a)
Mineral paints, zinc and lead pigments .....short tons..	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	(a)	(a)	(a)	(a)
Molybdenum.....pounds..	43,328	38,995	1,113	1,370
Petroleum.....barrels..			(a)	(a)
Salt.....short tons..	(a)	(a)	(a)	(a)
Sand and gravel.....do....	(a)	(a)	(a)	(a)
Silver.....troy ounces..	782,421	782,421	837,418	937,908
Stone.....short tons..	(c)	86,343	52,990	56,373
Tungsten ore (60 per cent concentrates)..do....	4	4,800		
Zinc.....do....	12,025	2,188,579	3,797	554,409
Miscellaneous.....		274,234		229,145
Total value, eliminating duplications.....		40,631,024		22,679,960

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

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Mineral production of New York in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Aluminum.....pounds..	(a b)	(a b)	(a b)	(a b)
Cement.....barrels..	c 4,074,159	c $6,568,746	4,441,250	$7,700,406
Clay products.....	.....	9,581,796	.....	14,468,586
Clay, raw.....short tons..	10,120	b 41,541	(a b)	(a b)
Coke.....do....	1,069,587	a 9,920,419	751,067	b 5,754,699
Diatomaceous earth.....do....	(a)	(a)	(a)	(a)
Emery.....do....	8,183	61,660	1,563	13,459
Feldspar.....do....	12,631	71,590	(a)	(a)
Ferroalloys.....long tons..	45,961	b 8,289,765	16,365	b 2,461,276
Garnet, abrasive.....short tons..	4,126	232,661	4,623	301,252
Gems and precious stones.....	.....	(a)	.....	.....
Graphite:				
Artificial.....pounds..	9,182,272	(a b)	8,163,177	(a b)
Crystalline.....do....	3,266,518	273,188	(a)	(a)
Gypsum.....short tons..	531,038	2,670,099	591,153	3,530,743
Iron ore:				
Sold to furnaces.....long tons..	899,970	5,802,870	701,688	4,002,312
Sold for paint.....do....	3,032	(a)	8,638	(a)
Iron, pig.....do....	2,482,450	b 70,167,542	1,854,594	b 49,784,659
Lead.....short tons..	29	4,161	.....	.....
Lime.....do....	87,127	913,366	126,404	1,131,860
Magnesium.....pounds..	(a b)	(a b)	(a b)	(a b)
Marl, calcareous.....short tons..	(a)	(a)	.....	.....
Millstones.....	.....	25,488	.....	10,155
Mineral waters.....gallons sold..	5,887,746	566,910	6,537,966	815,615
Natural gas.....M cubic feet..	8,460,583	5,673,131	8,123,889	2,843,400
Natural-gas gasoline.....gallons..	218,131	55,405	457,985	84,083
Peat.....short tons..	3,251	46,030	177	1,322
Petroleum.....barrels..	808,843	3,307,814	851,000	3,100,000
Potash (K_2O).....short tons..	(a)	(a)	(a)	(a)
Pyrites.....long tons..	63,982	422,958	60,544	468,257
Salt.....short tons..	2,130,530	7,336,867	1,947,829	7,159,547
Sand and gravel.....do....	4,172,733	2,176,472	3,987,987	2,246,880
Sand-lime brick.....thousands..	6,776	79,515	10,958	159,399
Silica (quartz).....short tons..	(a)	(a)	(a)	(a)
Silver.....troy ounces..	129	129	.....	.....
Slate.....	.....	11,383	.....	450,379
Slate granules.....short tons..	(d)	(d)	.....	
Stone.....do....	(e)	5,208,752	4,093,210	5,856,875
Talc.....do....	71,167	902,100	62,495	750,765
Zinc.....do....	3,776	687,230	5,120	747,666
Miscellaneous.....	.....	29,125,814	.....	25,905,752
Total value, eliminating duplications.....	.....	52,768,877	.....	56,379,564

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Exclusive of natural cement, value for which is included under "Miscellaneous."
d Included in figures for Vermont. Not separable.
e Figures for quantity not available for 1918.

Mineral production of North Carolina in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Aluminum.....pounds..	(a b)	(a b)	(a b)	(a b)
Asbestos.....short tons..	(a)	(a)	(a)	(a)
Barytes.....do....	(a)	(a)	(a)	(a)
Chromite.....long tons..	124	(a)		
Clay products.....		$1,589,508		$3,255,489
Clay, raw.....short tons..	16,054	b 222,205	(a b)	(a b)
Coal.....do....	1,420	6,745	6,989	26,871
Copper.....pounds..			3,334	620
Corundum.....short tons..	(a)	(a)		
Emery.....do....	300	2,100		
Feldspar.....do....	40,020	160,275	25,195	116,826
Garnet, abrasive.....do....	(a)	(a)	(a)	(a)
Gems and precious stones.....		255		
Gold.....troy ounces..	79	1,631	1	20
Iron ore.....long tons..	108,332	604,592	58,778	231,530
Lime.....short tons..	(a)	(a)	(a)	(a)
Manganese ore.....long tons..	315	(a)		
Manganiferous ore.....do....	30	(a)	30	(a)
Marl, calcareous.....short tons..	29,634	86,585	20,000	80,000
Mica:				
Scrap.....do....	1,046	12,930	1,639	32,338
Sheet.....pounds..	941,200	460,450	1,021,306	331,498
Millstones.....		39,224		29,025
Mineral waters.....gallons sold..	65,422	8,174	62,925	10,895
Peat.....short tons..	(a)	(a)	(a)	(a)
Sand and gravel.....do....	458,578	209,553	600,887	266,631
Silica (quartz).....do....	3,497	9,352	(a)	(a)
Silver.....troy ounces..	17	17	19	21
Stone.....short tons..	(c)	1,581,381	629,550	1,683,203
Talc.....do....	1,661	72,348	2,602	76,158
Miscellaneous.....		7,125,334		8,362,611
Total value, eliminating duplications.....		4,973,386		6,223,953

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of North Dakota in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel.....short tons..			(a b)	(a b)
Clay products.....		$176,843		$303,657
Clay, raw.....short tons..	(a b)	(a b)		
Coal.....do....	719,733	1,629,668	840,959	2,100,303
Gems and precious stones.....		(a)		
Mineral waters.....gallons sold..	530,000	13,700	110,000	1,100
Natural gas.....M cubic feet..	913	475	2,291	800
Sand and gravel.....short tons..	(a)	(a)	(a)	(a)
Sand-lime brick.....thousands..	(a)	(a)	(a)	(a)
Miscellaneous.....		2,976		8,915
Total value, eliminating duplications.....		1,823,109		2,413,025

a Value included under "Miscellaneous."
b Value not included in total value for State.

Mineral production of Ohio in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	(a)	(a)	(a)	(a)
Bromine.....pounds..	(a)	(a)	(a)	(a)
Calcium chloride.....short tons..	(a)	(a)	(a)	(a)
Cement.....barrels..	b 1, 289, 887	b $2, 208, 119	b 1, 821, 597	b $3, 311, 179
Clay products.....	.....	52, 899, 180	.....	63, 787, 319
Clay, raw.....short tons..	405, 353	c 744, 215	212, 534	c 464, 901
Coal.....do....	45, 812, 943	118, 095, 518	35, 876, 682	79, 496, 301
Coke.....do....	5, 365, 243	c 36, 691, 406	5, 481, 660	c 30, 703, 614
Ferroalloys.....long tons..	79, 932	c 3, 708, 552	53, 109	c 2, 292, 888
Grindstones and pulpstones.....short tons..	53, 198	1, 356, 264	39, 835	1, 060, 875
Gypsum.....do....	199, 456	1, 239, 649	251, 259	2, 049, 723
Iron, pig.....long tons..	8, 711, 205	c 263, 189, 621	6, 994, 999	c 178, 999, 271
Lime.....short tons..	489, 893	4, 640, 536	512, 614	4, 477, 987
Mineral waters.....gallons sold..	2, 771, 485	150, 711	2, 341, 853	142, 970
Natural gas.....M cubic feet..	61, 261, 069	24, 234, 741	61, 964, 488	19, 828, 600
Natural-gas gasoline.....gallons..	6, 744, 907	1, 355, 447	8, 800, 961	1, 963, 763
Oilstones and scythestones.....short tons..	200	20, 023	212	19, 739
Petroleum.....barrels..	7, 285, 005	23, 465, 197	7, 736, 000	23, 333, 000
Potash (K_2O).....short tons..	(a)	(a)	55	13, 079
Pyrites.....long tons..	9, 845	40, 215	4, 609	16, 886
Salt.....short tons..	1, 089, 887	3, 273, 390	991, 730	2, 362, 941
Sand and gravel.....do....	6, 001, 240	4, 939, 604	6, 439, 979	4, 601, 392
Sand-lime brick.....thousands..	(a)	(a)	(a)	(a)
Stone.....short tons..	(d)	7, 917, 740	8, 011, 530	8, 009, 649
Sulphuric acid e.....do....	(e)	(e)	(a)	(a)
Miscellaneous.....	.....	325, 881	.....	354, 485
Total value, eliminating duplications.....	.....	246, 162, 215	.....	214, 829, 888

a Value included under "Miscellaneous."
b Exclusive of natural cement, value for which is included under "Miscellaneous."
c Value not included in total value for State.
d Figures for quantity not available for 1918.
e From zinc smelting. No canvass for 1918. Figures for 1919 according to Bureau of Census.

Mineral production of Oklahoma in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	115, 848	$1, 382, 988	178, 711	$1, 857, 513
Cement.....barrels..	1, 218, 841	2, 203, 041	1, 366, 884	2, 657, 339
Clay products.....	.....	1, 496, 490	.....	2, 190, 129
Coal.....short tons..	4, 813, 447	17, 508, 884	3, 802, 113	14, 544, 901
Coke.....do....	(a b)	(a b)	(a b)	(a b)
Gypsum.....do....	126, 208	637, 644	114, 313	708, 660
Lead.....do....	56, 097	7, 965, 774	53, 872	5, 710, 432
Lime.....do....	(a)	(a)	(a)	(a)
Mineral paints, zinc and lead pigments....do....	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	1, 166, 485	20, 249	1, 368, 375	41, 825
Natural gas.....M cubic feet..	124, 317, 179	15, 805, 135	163, 148, 647	19, 577, 800
Natural-gas gasoline.....gallons..	163, 700, 550	28, 389, 045	189, 995, 038	32, 564, 532
Petroleum.....barrels..	103, 347, 070	231, 136, 205	86, 911, 000	184, 100, 000
Salt.....short tons..	(a)	(a)	.....	.....
Sand and gravel.....do....	383, 747	215, 862	467, 482	304, 029
Stone.....do....	(c)	696, 195	664, 710	726, 059
Tripoli.....do....	(d)	(d)	(a)	(a)
Zinc.....do....	161, 401	29, 374, 982	178, 410	26, 047, 860
Miscellaneous.....	.....	537, 211	.....	656, 989
Total value, eliminating duplications.....	.....	336, 857, 921	.....	291, 078, 174

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.
d Included in Missouri figures. Not separable.

Mineral production of Oregon in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	(a)	(a)		
Briquets, fuel.....do....	(a b)	(a b)	(a b)	(a b)
Cement.....barrels..	(a)	(a)	(a)	(a)
Chromite.....long tons..	18,454	$855,050	538	$9,752
Clay products.....		c 232,564		c 378,963
Clay, raw.....short tons..	(a b)	(a b)	(a b)	(a b)
Coal.....do....	13,328	37,454	18,739	63,794
Copper.....pounds..	2,451,016	605,401	2,214,815	411,955
Diatomaceous earth.....short tons..			(a)	(a)
Ferroalloys.....long tons..	(a b)	(a b)	(a b)	(a b)
Gems and precious stones.....		780		3,025
Gold.....troy ounces..	61,459	1,270,465	47,303	977,845
Gypsum.....short tons..	(a)	(a)	(a)	(a)
Lead.....do....	5	753		
Lime.....do....	2,257	26,884	(a)	(a)
Manganese ore.....long tons..	198	(a)		
Mineral waters.....gallons sold..	13,550	1,825	2,600	1,140
Natural gas.....M cubic feet..	2,200	550	200	100
Platinum and allied metals.....troy ounces..	65	7,185	86	12,567
Quicksilver.....flasks..	702	82,485	435	39,276
Sand and gravel.....short tons..	473,745	193,559	797,288	506,526
Silver.....troy ounces..	107,323	107,323	111,121	124,455
Stone.....short tons..	(d)	233,521	523,040	728,863
Miscellaneous.....		804,675		1,058,272
Total value, eliminating duplications.....		4,191,740		3,962,822

a Value not included in total value for State.
b Value included under "Miscellaneous."
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Figures for quantity not available for 1918.

Mineral production of Pennsylvania in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Briquets, fuel.....short tons..	143,294	a $588,569	39,173	a $161,958
Cement.....barrels..	b 22,238,689	b 33,600,956	b 26,250,077	b 43,126,528
Clay products.....	.....	40,467,104	.....	39,270,613
Clay, raw.....short tons..	591,685	a 1,697,228	415,097	a 1,349,466
Coal:				
Anthracite.....do....	98,826,084	336,480,347	88,092,201	364,926,950
Bituminous.....do....	178,550,741	463,159,736	150,758,154	365,430,504
Coke.....do....	26,723,645	a 160,357,274	20,501,831	a 102,902,920
Copper.....pounds..	779,393	192,510	.....	.....
Feldspar.....short tons..	4,916	57,269	(c)	(c)
Ferroalloys.....long tons..	448,204	a 72,897,550	218,259	a 31,067,123
Gems and precious stones.....	.....	(c)	.....	.....
Graphite, crystalline.....pounds..	1,016,900	112,059	484,060	26,003
Iron ore:				
Sold to furnaces.....long tons..	515,845	982,173	616,271	1,340,219
Sold for paint.....do....	.....	.....	4,183	36,130
Iron, pig.....do....	14,701,252	a 465,859,029	11,901,992	a 307,824,587
Lime.....short tons..	801,834	6,654,407	779,608	6,181,710
Marl, calcareous.....do....	(c)	(c)	1,500	9,750
Millstones.....	.....	(c)	.....	(c)
Mineral paints, zinc and lead pigments .....short tons..	(a c)	(a c)	(a c)	(a c)
Mineral waters.....gallons sold..	1,400,456	123,436	872,595	83,583
Natural gas.....M cubic feet..	123,813,358	38,608,883	113,527,916	31,787,800
Natural-gas gasoline.....gallons..	15,775,058	3,249,233	20,283,336	4,407,318
Peat.....short tons..	(c)	(c)	.....	.....
Pebbles for grinding.....do....	(c)	(c)	.....	.....
Petroleum.....barrels..	7,407,812	29,606,079	8,137,000	33,688,000
Potash (K_2O).....short tons..	348	148,590	330	93,134
Pyrites.....long tons..	(c)	(c)	(c)	(c)
Sand and gravel.....short tons..	6,302,677	7,207,840	5,699,306	5,892,679
Sand and sandstone (finely ground).....do....	(c)	(c)	.....	.....
Sand-lime brick.....thousands..	(c)	(c)	(c)	(c)
Silica (quartz).....short tons..	(c)	(c)	(c)	(c)
Slate.....	.....	2,304,647	.....	2,885,072
Stone.....short tons..	(d)	15,783,147	13,262,310	16,529,971
Sulphuric acid e.....do....	(e)	(e)	(c)	(c)
Talc.....do....	(c)	(c)	(c)	(c)
Tripoli (rottenstone).....do....	(c)	(c)	(c)	(c)
Miscellaneous.....	.....	22,098,633	.....	22,546,557
Total value, eliminating duplications.....	.....	979,245,098	.....	918,048,917

a Value not included in total value for State.
b Exclusive of natural cement, value for which is included under "Miscellaneous."
c Value included under "Miscellaneous."
d Figures for quantity not available for 1918.
e From zinc smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Rhode Island in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	(a)	.....	(a)
Coke.....short tons..	.....	.....	(a b)	(a b)
Graphite, amorphous.....do....	(a)	(a)	(a)	(a)
Lime.....do....	(a)	(a)	(a)	(a)
Mineral waters.....gallons sold..	365,705	$30,729	317,571	$26,039
Sand and gravel.....short tons..	(a)	(a)	8,950	11,142
Stone.....do....	(c)	577,494	117,700	635,112
Miscellaneous.....	.....	152,564	.....	1,028,690
Total value, eliminating duplications.....	.....	760,787	.....	853,981

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of South Carolina in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)	(a)	(a)
Clay products.....	.....	$605,768	.....	$1,071,471
Clay, raw.....short tons..	38,311	b 262,878	25,706	b 224,415
Copper.....pounds..	.....	.....	2,299	427
Gold.....troy ounces..	.....	.....	4	81
Manganese ore.....long tons..	100	(a)	.....	.....
Manganiferous ore.....do....	850	(a)	.....	.....
Marl, calcareous.....short tons..	(a)	(a)	(a)	(a)
Mica, sheet.....pounds..	(a)	(a)	.....	.....
Mineral waters.....gallons sold..	279,300	51,198	348,242	38,890
Phosphate rock.....long tons..	37,040	164,650	60,823	308,968
Pyrites.....do....	(a)	(a)	.....	.....
Sand and gravel.....short tons..	76,297	49,374	298,787	157,220
Silver.....troy ounces..	.....	.....	19	21
Stone.....short tons..	(c)	599,964	403,780	721,215
Tin (metallic equivalent).....do....	.....	300	.....	.....
Miscellaneous.....	.....	87,289	.....	72,623
Total value, eliminating duplications.....	.....	1,558,543	.....	2,370,916

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of South Dakota in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	$32,161	.....	$73,571
Clay, raw.....short tons..	(a b)	(a b)	(a b)	(a b)
Coal.....do....	7,942	22,230	14,417	45,707
Columbite (50 per cent Ta_2O_5).....pounds..	4,500	2,250	300	90
Copper.....do....	64,806	16,007	.....	.....
Gems and precious stones.....	.....	(a)	.....	(a)
Gold.....troy ounces..	317,598	6,565,337	235,250	4,863,040
Gypsum.....short tons..	(a)	(a)	(a)	(a)
Lead.....do....	27	3,792	16	1,725
Lime.....do....	4,772	40,490	4,205	56,540
Lithium minerals.....do....	1,755	37,100	1,727	46,600
Manganese ore.....long tons..	31	(a)	.....	.....
Mica:				
Scrap.....short tons..	(a)	(a)	(a)	(a)
Sheet.....pounds....	(a)	(a)	.....	.....
Mineral waters.....gallons sold..	454,865	17,269	785,404	23,961
Natural gas.....M cubic feet..	42,186	19,109	32,807	16,700
Pyrites.....long tons..	(a)	(a)	.....	.....
Sand and gravel.....short tons..	229,787	48,362	648,939	231,390
Sand-lime brick.....thousands..	1,249	13,617	(a)	(a)
Silver.....troy ounces..	159,202	159,202	116,493	130,472
Stone.....short tons..	(c)	97,894	140,400	222,490
Tin (metallic equivalent).....do....	.....	200	.....	.....
Tungsten ore (60 per cent concentrates)..do....	201	247,100	.....	.....
Miscellaneous.....	.....	123,611	.....	146,918
Total value, eliminating duplications.....	.....	7,441,981	.....	5,842,704

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Tennessee in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Aluminum.....pounds..	(a b)	(a b)	(a b)	(a b)
Barytes.....short tons..	22,542	$141,844	34,700	$288,622
Bauxite.....long tons..	(a)	(a)	(a)	(a)
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	2,791,867	.....	3,447,386
Clay, raw.....short tons..	88,962	b 350,333	42,482	b 189,705
Coal.....do....	6,831,048	19,305,203	5,213,205	14,448,168
Coke.....do....	427,106	b 3,176,614	260,915	b 1,907,670
Copper.....pounds..	14,799,680	3,655,521	15,623,589	2,905,988
Ferroalloys.....long tons..	37,366	b 2,586,524	24,565	b 1,395,327
Flint lining for tube mills.....short tons..	1,335	25,034	.....	.....
Gold.....troy ounces..	235	4,866	274	5,662
Iron ore:				
Sold to furnaces.....long tons..	408,954	1,184,546	282,988	817,549
Sold for paint.....do....	.....	.....	(a)	(a)
Iron, pig.....do....	342,538	b 11,672,606	155,663	b 5,152,860
Lead.....short tons..	1,705	242,139	2,188	231,928
Lime.....do....	106,527	682,450	116,346	958,816
Manganese ore.....long tons..	4,162	153,830	328	8,388
Manganiferous ore.....do....	2,358	43,545	35	(a)
Mineral waters.....gallons sold..	990,027	53,367	752,837	54,259
Natural gas.....M cubic feet..	1,826,725	361,140	77,441	5,400
Petroleum.....barrels..	8,374	21,704	15,000	37,000
Phosphate rock.....long tons..	363,737	1,849,546	524,333	3,347,692
Potash (K_2O).....short tons..	(a)	(a)	(a)	(a)
Pyrites.....long tons..	(a)	(a)	(a)	(a)
Sand and gravel.....short tons..	986,801	639,373	1,006,708	734,212
Silica (quartz).....do....	(a)	(a)	(a)	(a)
Silver.....troy ounces..	93,620	93,620	98,288	110,083
Slate.....	.....	(a)	.....	.....
Stone.....short tons..	(c)	1,493,858	677,110	1,762,596
Sulphuric acid d.....do....	(d)	(d)	(a)	(a)
Zinc.....do....	21,071	3,834,859	23,247	3,394,062
Miscellaneous.....	.....	8,413,594	.....	10,360,788
Total value, eliminating duplications.....	.....	39,229,614	.....	37,134,899

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.
d From copper smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Texas in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	186,909	$3,003,555	189,377	$2,656,567
Cement.....barrels..	1,918,919	3,297,977	2,318,747	4,226,222
Clay products.....	.....	3,026,559	.....	4,452,997
Clay, raw.....short tons..	2,980	[a] 13,879	21,841	[a] 43,487
Coal.....do....	2,261,135	5,937,997	1,680,656	4,527,640
Copper.....pounds..	9,308	2,299	979	182
Fuller's earth.....short tons..	[b]	[b]	[b]	[b]
Gems and precious stones.....	.....	[b]	.....	[b]
Gold.....troy ounces..	1	25	1	25
Graphite, crystalline.....pounds..	[b]	[b]	[b]	[b]
Gypsum.....short tons..	157,388	834,560	176,607	1,080,754
Iron ore.....long tons..	[b]	[b]	12,300	[b]
Iron, pig.....do....	.....	.....	[a b]	[a b]
Lead.....short tons..	13	1,913	7	696
Lime.....do....	45,206	363,022	49,831	459,279
Manganese ore.....long tons..	380	[b]	.....	.....
Mineral waters.....gallons sold..	544,183	80,553	328,913	60,125
Natural gas.....M cubic feet..	13,439,624	5,027,449	24,496,856	5,144,300
Natural-gas gasoline.....gallons..	7,326,122	1,214,565	9,336,437	1,772,503
Petroleum.....barrels..	38,750,031	74,867,537	79,366,000	157,729,000
Quicksilver.....flasks..	8,451	992,992	5,019	453,166
Salt.....short tons..	79,657	762,006	[b]	[b]
Sand and gravel.....do....	1,175,426	519,446	1,673,119	991,798
Sand-lime brick.....thousands..	2,560	27,384	[b]	[b]
Silver.....troy ounces..	576,565	576,565	538,642	603,279
Stone.....short tons..	[c]	647,287	650,360	630,584
Sulphur.....long tons..	[b]	[b]	[b]	[b]
Miscellaneous.....	.....	9,122,676	.....	5,833,782
Total value, eliminating duplications.....	.....	110,306,367	.....	190,563,015

[a] Value not included in total value for State.
[b] Value included under "Miscellaneous."
[c] Figures for quantity not available for 1918.

Mineral production of Utah in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asphalt.....short tons..	31,072	$663,258	33,992	$406,610
Cement.....barrels..	549,593	1,085,917	935,305	1,906,816
Clay products.....	.....	[a] 610,288	.....	[a] 1,071,997
Clay, raw.....short tons..	7,533	[b] 22,528	4,124	[b] 16,818
Coal.....do....	5,136,825	13,937,097	4,631,323	12,760,613
Coke.....do....	(b c)	(b c)	(b c)	(b c)
Copper.....pounds..	227,169,630	56,110,899	124,061,807	23,075,496
Diatomaceous earth.....short tons..	(c)	(c)	(c)	(c)
Fluorspar.....do....	20	(c)	(c)	(c)
Gems and precious stones.....	.....	(c)	.....	1,500
Gold.....troy ounces..	142,666	2,949,170	104,464	2,159,471
Gypsum.....short tons..	(c)	(c)	(c)	(c)
Iron ore.....long tons..	52,722	168,438	44,185	177,327
Lead.....short tons..	83,504	11,857,584	61,915	6,562,940
Lime.....do....	7,844	67,642	6,982	94,027
Manganese ore.....long tons..	5,100	140,038	.....	.....
Natural gas.....M cubic feet..	(c)	(c)	.....	.....
Phosphate rock.....long tons..	(c)	(c)	(c)	(c)
Potash (K_2O).....short tons..	3,864	1,841,124	4,173	1,153,175
Salt.....do....	94,204	580,375	77,336	432,130
Sand and gravel.....do....	184,719	103,873	383,372	190,606
Silver.....troy ounces..	13,455,597	13,455,597	11,649,961	13,047,956
Slate.....	.....	(c)	.....	400
Stone.....short tons..	(d)	355,579	318,730	333,342
Sulphuric acid [e].....do....	(e)	(e)	(c)	(c)
Tungsten ore (60 per cent concentrates)...do....	7	8,300	.....	.....
Uranium and vanadium ores.....	.....	63,000	.....	28,350
Zinc.....short tons..	9,200	1,674,347	2,216	323,465
Miscellaneous.....	.....	3,331,249	.....	2,323,114
Total value, eliminating duplications.....	.....	105,785,474	.....	64,165,525

[a] Exclusive of pottery, value for which is included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value included under "Miscellaneous."
[d] Figures for quantity not available for 1918.
[e] From copper smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Vermont in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Clay products.....	.....	$87,609	.....	(a)
Clay, raw.....short tons..	(a b)	(a b)	(a b)	(a b)
Copper.....pounds..	1,116,384	275,747	582,468	$108,339
Gold.....troy ounces..	4	83	18	377
Lime.....short tons..	35,728	382,363	37,850	436,000
Mineral waters.....gallons sold..	95,700	17,090	107,600	15,755
Sand and gravel.....short tons..	47,059	10,462	52,323	12,861
Scythestones.....do....	(a)	(a)	(a)	(a)
Silver.....troy ounces..	3,440	3,440	2,214	2,480
Slate.....	.....	1,279,987	.....	2,143,648
Slate granules.....short tons..	(a c)	(a c)	.....	
Stone.....do....	(d)	5,505,895	273,130	8,219,459
Talc and soapstone.....do....	90,612	778,012	78,661	665,652
Miscellaneous.....	.....	846,366	.....	170,333
Total value, eliminating duplications.....	.....	9,158,945	.....	11,728,052

[a] Value included under "Miscellaneous."
[b] Value not included in total value for State.
[c] Value of New York production included with Vermont. Not separable.
[d] Figures for quantity not available for 1918.

Mineral production of Virginia in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)	(a)	(a)
Briquets, fuel.....do....	(a b)	(a b)	(a b)	(a b)
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	$1,666,854	.....	$2,774,573
Clay, raw.....short tons..	9,003	b 32,923	(a b)	(a b)
Coal.....do....	10,289,808	25,865,895	9,326,830	23,774,941
Coke.....do....	1,234,256	b 8,046,115	930,516	b 5,391,387
Diatomaceous earth.....do....	(a)	(a)	.....	.....
Emery.....do....	(a)	(a)	(a)	(a)
Ferroalloys.....long tons..	40,383	b 7,367,035	(a b)	(a b)
Gems and precious stones.....	.....	(a)	.....	.....
Gold.....troy ounces..	19	400	.....	.....
Gypsum.....short tons..	(a)	(a)	(a)	(a)
Iron ore:				
Sold to furnaces.....long tons..	400,135	1,365,582	304,920	1,139,349
Sold for paint.....do....	.....	.....	(a)	(a)
Iron, pig.....do....	453,863	b 15,430,473	288,458	b 9,094,135
Lead.....short tons..	815	115,683	.....	.....
Lime.....do....	249,990	1,629,567	223,768	1,805,627
Manganese ore.....long tons..	10,928	500,528	3,928	142,431
Manganiferous ore.....do....	12,776	127,533	9,765	(a)
Marl, calcareous.....short tons..	39,770	100,518	51,154	176,780
Mica:				
Scrap.....do....	404	4,280	578	7,811
Sheet.....pounds..	78,500	46,200	(a)	(a)
Millstones.....	.....	(a)	.....	(a)
Mineral paints, zinc and lead pigments .....short tons..	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	1,745,105	173,912	1,418,528	143,199
Pyrites.....long tons..	143,427	841,177	119,164	891,308
Salt.....short tons..	(a)	(a)	(a)	(a)
Sand and gravel.....do....	1,331,123	764,618	1,565,592	1,349,148
Sand and sandstone (finely ground)....do....	(a)	(a)	.....	.....
Silver.....troy ounces..	1,814	1,814	.....	.....
Slate.....	.....	109,723	.....	200,282
Stone.....short tons..	(c)	1,638,077	1,632,960	1,705,749
Talc and soapstone.....do....	18,520	597,782	17,663	542,022
Titanium minerals:				
Ilmenite.....do....	444	11,100	106	2,120
Rutile.....do....	261	39,150	102	20,400
Zinc.....do....	951	173,081	.....	.....
Miscellaneous.....	.....	2,145,596	.....	4,411,199
Total value, eliminating duplications.....	.....	37,639,368	.....	36,799,407

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

Mineral production of Washington in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	.....	.....	(a)	(a)
Briquets, fuel.....do....	(a b)	(a b)	(a b)	(a b)
Cement.....barrels..	1,116,754	$2,114,730	1,402,616	$2,868,599
Chromite.....long tons..	(a)	(a)	.....	.....
Clay products.....	.....	c 1,274,708	.....	1,764,264
Clay, raw.....short tons..	3,435	b 17,637	20,518	b 21,964
Coal.....do....	4,082,212	14,132,869	2,990,447	10,691,222
Coke.....do....	123,788	b 1,196,685	62,546	b 531,160
Copper.....pounds..	1,922,406	474,834	1,676,576	311,843
Diatomaceous earth.....short tons..	(a)	(a)	974	14,821
Ferroalloys.....long tons..	(a b)	(a b)	(a b)	(a b)
Fluorspar.....short tons..	(a)	(a)	.....	.....
Gems and precious stones.....	.....	(a)	.....	(a)
Gold.....troy ounces..	14,738	304,658	12,232	252,862
Iron ore.....long tons..	(a)	(a)	2,750	(a)
Iron, pig.....do....	15,780	(a b)	(a b)	(a b)
Lead.....short tons..	2,636	374,299	1,073	113,746
Lime.....do....	22,118	226,104	19,534	232,723
Magnesite.....do....	147,528	1,050,790	106,206	743,442
Mineral waters.....gallons sold..	(a)	(a)	(a)	(a)
Natural gas.....M cubic feet..	(a)	(a)	.....	.....
Platinum and allied metals.....troy ounces..	10	1,075	.....	.....
Potash (K_2O).....short tons..	(a)	(a)	(a)	(a)
Sand and gravel.....do....	908,102	332,141	1,231,814	536,132
Sand-lime brick.....thousands..	(a)	(a)	.....	.....
Silver.....troy ounces..	310,093	310,093	259,384	290,510
Stone.....short tons..	(d)	365,098	261,310	423,653
Talc.....do....	.....	.....	(a)	(a)
Tungsten ore (60 per cent concentrates)..do....	1	800	.....	.....
Zinc.....do....	19	3,537	.....	.....
Miscellaneous.....	.....	1,360,720	.....	493,007
Total value, eliminating duplications.....	.....	20,999,691	.....	18,267,938

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Figures for quantity not available for 1918.

Mineral production of West Virginia in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Bromine.....pounds..	77,094	$69,606	54,478	$27,852
Calcium chloride.....short tons..	3,467	57,232	1,692	26,876
Cement.....barrels..	(a)	(a)	(a)	(a)
Clay products.....	.....	10,988,677	.....	12,947,598
Clay, raw.....short tons..	120,437	b216,771	71,979	b123,951
Coal.....do....	89,935,839	230,508,846	79,036,553	196,551,015
Coke.....do....	3,320,006	b22,152,844	1,413,932	b7,672,593
Grindstones and pulpstones.....do....	7,331	306,042	6,092	254,095
Iron, pig.....long tons..	342,573	(a b)	250,310	b6,267,067
Lime.....short tons..	167,901	1,194,610	174,167	1,274,294
Marl, calcareous.....do....	(a)	(a)	5,875	17,625
Mineral waters.....gallons sold..	301,883	32,045	271,907	33,796
Natural gas.....M cubic feet..	265,160,917	41,324,365	231,336,215	34,700,400
Natural-gas gasoline.....gallons..	37,603,903	7,498,804	52,150,045	12,179,638
Petroleum.....barrels..	7,866,628	31,652,018	8,327,000	34,890,000
Salt.....short tons..	26,077	251,668	18,599	167,529
Sand and gravel.....do....	904,148	1,438,887	1,183,606	1,750,201
Sand and sandstone (finely ground).....do....	(a)	(a)	(a)	(a)
Stone.....do....	(c)	2,024,525	1,995,210	2,270,618
Sulphuric acid d.....do....	(d)	(d)	(a)	(a)
Miscellaneous.....	.....	10,609,024	.....	926,657
Total value, eliminating duplications.....	.....	327,962,620	.....	298,018,194

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.
d From zinc smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Wisconsin in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Barytes.....short tons..	(a)	(a)	(a)	(a)
Briquets, fuel.....do....	(a b)	(a b)	(a b)	(a b)
Clay products.....	.....	c$874,172	.....	c$1,203,757
Clay, raw.....short tons..	(a b)	(a b)	.....	.....
Coke.....do....	(a b)	(a b)	(a b)	(a b)
Iron ore:				
Sold to furnaces.....long tons..	1,167,640	3,796,408	881,740	3,253,290
Sold for paint.....do....	2,597	5,026	1,086	(a)
Iron, pig.....do....	363,225	b13,832,908	282,830	b 8,320,521
Lead.....short tons..	4,533	643,686	4,214	446,684
Lime.....do....	109,303	740,700	123,620	1,094,725
Mineral paints, zinc and lead pigments..do....	(a b)	(a b)	(a b)	(a b)
Mineral waters.....gallons sold..	6,630,725	1,193,345	5,113,289	1,446,367
Potash (K_2O).....short tons..	376	376,586	392	247,496
Pyrites.....long tons..	(a)	(a)	26,053	19,287
Sand and gravel.....short tons..	2,170,312	809,884	2,763,249	1,543,434
Sand-lime brick.....thousands..	(a)	(a)	(a)	(a)
Silica (quartz).....short tons..	(a)	(a)	(a)	(a)
Stone.....do....	(d)	2,392,456	1,556,880	3,179,894
Sulphuric acid e.....do....	(e)	(e)	(a)	(a)
Zinc.....do....	50,014	9,102,548	40,765	5,951,690
Miscellaneous.....	.....	11,711,577	.....	9,876,530
Total value, eliminating duplications.....	.....	20,091,146	.....	18,772,601

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Exclusive of pottery, value for which is included under "Miscellaneous."
d Figures for quantity not available for 1918.
e From zinc smelting. No canvass for 1918. Figures for 1919 according to Bureau of the Census.

Mineral production of Wyoming in 1918 and 1919.

Product.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Asbestos.....short tons..	.....	.....	(a)	(a)
Chromite.....long tons..	263	$5,124	1,200	$35,620
Clay products.....	.....	110,091	.....	194,350
Clay, raw.....short tons..	(a b)	(a b)	(a b)	(a b)
Coal.....do....	9,438,688	22,581,019	7,219,738	18,751,024
Copper.....pounds..	852,777	210,636	139,900	26,021
Gems and precious stones.....	.....	(a)	.....	(a)
Gold.....troy ounces..	42	871	4	84
Gypsum.....short tons..	41,877	195,143	51,079	282,587
Iron ore.....long tons..	447,884	(a)	398,613	(a)
Lime.....short tons..	(a)	(a)	(a)	(a)
Manganese ore.....long tons..	42	(a)	.....	.....
Manganiferous ore.....do....	50	(a)	.....	.....
Mica, sheet.....pounds..	(a)	(a)	.....	.....
Mineral waters.....gallons sold..	41,335	5,513	(a)	(a)
Natural gas.....M cubic feet..	4,338,840	156,171	6,013,867	420,970
Natural-gas gasoline.....gallons..	1,579,526	268,339	5,580,599	931,722
Petroleum.....barrels..	12,596,287	18,159,778	13,172,000	19,544,000
Phosphate rock.....long tons..	.....	.....	81	300
Platinum and allied metals.....troy ounces..	(a)	(a)	(a)	(a)
Potash (K_2O).....short tons..	.....	.....	(a)	(a)
Sand and gravel.....do....	502,746	50,293	349,181	40,825
Silver.....troy ounces..	965	965	151	169
Sodium sulphate from natural sources..... short tons..	(a)	(a)	(a)	(a)
Stone.....do....	(c)	182,087	118,040	212,608
Uranium and vanadium ores.....	.....	10,322	.....	27,473
Miscellaneous.....	.....	661,735	.....	637,456
Total value, eliminating duplications.....	.....	42,595,812	.....	41,100,209

a Value included under "Miscellaneous."
b Value not included in total value for State.
c Figures for quantity not available for 1918.

PREFATORY NOTE TO THE REPORTS ON GOLD, SILVER, COPPER, LEAD, AND ZINC.

By G. F. Loughlin,
Geologist in Charge, Division of Mineral Resources.

In the mining industry gold, silver, copper, lead, and zinc are closely related in both the genesis and the geologic occurrence of their ores, as well as in mining and in metallurgic treatment. Of their ores some contain all five metals, many contain three or four, and few contain only one. Gold and silver, for instance, almost everywhere show close genetic relations, and their ores are usually mined together. Lead and zinc constitute a similar pair. Copper ores almost invariably yield some silver and gold as well as copper, and most lead ores yield notable supplies of silver. Zinc ores in the Western States contribute also to the production of silver. All five metals may occur in commercial quantity in a single mine or, more commonly, in a single mining district. For these reasons each of these metals is treated in Mineral Resources in a general report, and all five metals are grouped together in "mines reports" descriptive of individual or geographically grouped States. These reports are published in 16 separate pamphlets.

To facilitate advance publication each report is published separately at the earliest date possible. The general reports give figures of the output of the metals in the first marketable form, as obtained from the smelters, refineries, and mints, together with general reviews of the respective industries for the entire country. The figures given in the general reports represent the final official statistics of production for the country and of the States. The general report on gold and silver includes the statistics of recovered precious metals as determined jointly by the Bureau of the Mint and the United States Geological Survey. The "mines reports" give figures of the production (called "mine production") as obtained from the mines, so far as possible in terms of recoverable metal in ores and other material sold or treated during the year; they also supply information in detail relative to the mining industry in the respective States, counties, and mining districts.

These reports, which appear as separate chapters in this volume, are as follows:

Gold and silver (general report).
Copper (general report).
Lead (general report).
Zinc (general report).
Gold, silver, copper, lead, and zinc in the Eastern States (mines report).
Silver, copper, lead, and zinc in the Central States (mines report).
Gold, silver, copper, and lead in Alaska (mines report).
Gold, silver, copper, lead, and zinc in Arizona (mines report).
Gold, silver, copper, lead, and zinc in California and Oregon (mines report).
Gold, silver, copper, lead, and zinc in Colorado (mines report).
Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
Gold, silver, copper, lead, and zinc in Montana (mines report).
Gold, silver, copper, lead, and zinc in Nevada (mines report).
Gold, silver, copper, lead, and zinc in New Mexico and Texas (mines report).
Gold, silver, copper, and lead in South Dakota and Wyoming (mines report).
Gold, silver, copper, lead, and zinc in Utah (mines report).

In stating quantity of ores, concentrates, and similar material the short ton of 2,000 pounds is used throughout. The term "ore" as used here denotes any metalliferous material treated at the mine or shipped to reduction plants and paid for by those plants, whether or not it nets a profit to the miner. The ore classification is necessarily arbitrary because of the varying factors affecting mining and treatment of ores. Dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores that carry considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and also gold and silver ores that carry copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The copper ores include the great disseminated copper deposits of the West, the copper ores of the Lake Superior region, and other ores in which copper is the most abundant base metal paid for. The lead and zinc ores are those in which lead or zinc is the only or chief base metal present, irrespective of their precious-metal content. The mixed ores are those whose commercial value depends on the recoverable or recovered contents of two or more base metals in addition to any precious metals they may contain. If one of the metals, though present in sufficient quantity, is not recovered, that metal is disregarded in naming the ore. An improvement in metallurgy may later serve to change the name of such ore. This classification based on methods of treatment is the only satisfactory commercial classification.

It is to be understood, of course, that market values are not received by producers for metals in ore and intermediate products, nor always for metals in marketable form, that payment is made in accordance with contracts for treatment or sale, and therefore that average daily quotations do not necessarily agree with average prices received.

Any of the reports mentioned here may be obtained, as long as the supply lasts, on request made to the Director, United States Geological Survey, Washington, D. C.

Prices of silver, copper, lead, and zinc, 1850 to 1919.

Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]	Year.	Silver.[a]	Copper.[b]	Lead.[c]	Zinc.[d]
	Fine ounce.	*Pound.*	*Pound.*	*Pound.*		*Fine ounce.*	*Pound.*	*Pound.*	*Pound.*
1850	$1.32	$0.22	$0.05	.....	1885	$1.07	$0.108	$0.040	$0.043
1851	1.34	.166	.05	.....	1886	.99	.111	.046	.044
1852	1.33	.22	.05	.....	1887	.98	.138	.045	.046
1853	1.35	.22	.06	$0.055	1888	.94	.168	.044	.049
1854	1.35	.22	.06	.....	1889	.94	.135	.039	.05
1855	1.34	.27	.07	.....	1890	1.05	.156	.045	.055
1856	1.34	.27	.066	.....	1891	.99	.128	.043	.05
1857	1.35	.25	.06	.....	1892	.87	.116	.041	.046
1858	1.34	.23	.06	.....	1893	.78	.108	.037	.04
1859	1.36	.22	.055	.....	1894	.63	.095	.033	.035
1860	1.35	.23	.056	.....	1895	.65	.107	.032	.036
1861	1.33	.22	.05	.....	1896	.68	.108	.03	.039
1862	1.35	.22	.06	.....	1897	.60	.12	.036	.041
1863	1.345	.34	.06	.....	1898	.59	.124	.038	.046
1864	1.345	.47	.07	.139	1899	.60	.171	.045	.058
1865	1.337	.392	.066	.....	1900	.62	.166	.044	.044
1866	1.339	.342	.07	.....	1901	.60	.167	.043	.041
1867	1.33	.254	.065	.....	1902	.53	.122	.041	.048
1868	1.326	.23	.065	.....	1903	.54	.137	.042	.054
1869	1.325	.242	.06	.....	1904	.58	.128	.043	.051
1870	1.328	.212	.06	.....	1905	.61	.156	.047	.059
1871	1.325	.241	.06	.....	1906	.68	.193	.057	.061
1872	1.322	.356	.064	.....	1907	.66	.20	.053	.059
1873	1.297	.280	.06	.....	1908	.53	.132	.042	.047
1874	1.278	.220	.06	.....	1909	.52	.13	.043	.054
1875	1.24	.227	.058	.07	1910	.54	.127	.044	.054
1876	1.16	.21	.061	.072	1911	.53	.125	.045	.057
1877	1.20	.19	.055	.06	1912	.615	.165	.045	.069
1878	1.15	.166	.036	.049	1913	.604	.155	.044	.056
1879	1.12	.186	.041	.052	1914	.553	.133	.039	.051
1880	1.15	.214	.05	.055	1915	.507	.175	.047	.124
1881	1.13	.182	.048	.052	1916	.658	.246	.069	.134
1882	1.14	.191	.049	.053	1917	.824	.273	.086	.102
1883	1.11	.165	.043	.045	1918	.98	.217	.071	.091
1884	1.11	.13	.037	.044	1919	1.12	.186	.053	.073

[a] Report of Director of the Mint, pp. 212-213, 1914. Equivalent value of fine ounce based on average price and average rate of exchange. For 1916, 1917, and 1919 dealers buying price, New York. Price given by Bureau of Mint early in 1919 as the approximate average selling price of all silver sold in 1918 was $1 a fine ounce, and this price was used by the Geological Survey in computing value of mine production of silver. The price of 98 cents a fine ounce, later given by the Mint, has been used in computing value of smelter output of silver in all Mint-Survey cooperative tables.

[b] Weed, W. H., Copper Handbook, vol. 11, pp. 1339, 1343, for years 1850–1903. By computation from data for years 1850–1860, p. 1339. Survey computations for electrolytic copper since 1904. For 1916 and later years average price all marketable grades.

[c] New York price, Ingalls, W. R., Lead and zinc in the United States, p. 203, 1908. U. S. Geological Survey since 1904. For 1916, outside spot quotations, New York. For 1917 and later years average price all grades.

[d] New York price, 1875–1904, Ingalls, W. R., Lead and zinc in the United States, p. 342, 1908. St. Louis price, U. S. Geological Survey since 1904. For 1915 and later years average price all grades. According to C. E. Siebenthal for 1853 and 1864.

CADMIUM.

By C. E. Siebenthal.

INTRODUCTION.

An account of the production, resources, metallurgy, and uses of cadmium was given as a chapter in Mineral Resources for 1908. Another account describing in some detail the cadmium-bearing by-products produced in the United States and their possibilities as commercial sources of cadmium and giving the results of attempts to substitute cadmium for tin in solders was included in the chapter on Cadmium in Mineral Resources for 1918. A more detailed report is in preparation and will be published as a bulletin of the United States Geological Survey.

The present report gives the production of cadmium in the United States since the beginning of the industry in 1906, the imports for 1903 and later years, the range of fluctuation in price in 1919, and the yearly average selling price since 1906.

PRODUCTION.

Cadmium was first produced in the United States by the Grasselli Chemical Co. in 1906. Now there are six producing plants operated by the American Smelting & Refining Co., Grasselli Chemical Co., Krebs Pigment & Chemical Co., Midland Chemical Co., and United States Smelting, Refining & Mining Co. (including the lead smelter at Midvale, Utah, and the electrolytic zinc plant at Kennett, Calif.). Several other electrolytic zinc plants and lithopone plants save cadmium-bearing residues and have worked out processes for recovering the metal. An extension of the uses of cadmium and an increased demand for it would result in additions to the list of producers. Several companies that produce cadmium-bearing residues have sold them to other companies already equipped to recover the metal. This practice points the way to custom cadmium-reduction plants large enough to handle economically the product of companies whose output is too small to justify individual reduction plants.

Cadmium is produced in the United States in two forms—metallic cadmium and the pigment, cadmium sulphide. The domestic production of metallic cadmium in 1907 was nearly sufficient to supply the home demand, a fact shown by the small imports for that year (see p. 4), but in 1908 the quantity of cadmium imported was almost doubled, and in 1909–1912 the imports were back at the figures that prevailed before cadmium had been produced in the United States. Since 1912, however, the domestic production has made great strides,

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and as a result the imports of cadmium are again small. As the imports came largely from Germany they have been practically stopped for the last six years.

The following table, compiled from reports by each producer of cadmium in the United States and from official reports of the German Government, shows that the production of cadmium in the United States since 1910 has gained rapidly on that of Germany. Taken together the production of these two countries has constituted practically the whole cadmium production of the world, though a small output is being made at the electrolytic zinc plants of Brunner, Mond & Co. and Chance & Hunt, in England, and some cadmium will doubtless be produced at the electrolytic zinc plant at Hobart, Tasmania.

Metallic cadmium and cadmium sulphide produced in the United States and Germany, 1906–1919.

Year.	United States.						Germany.		
	Metallic cadmium.			Cadmium sulphide.			Metallic cadmium.		
	Quantity (pounds).	Value.	Average price per pound.	Quantity (pounds).	Value.	Average price per pound.	Quantity (pounds).	Value.	Average price per pound.
1906	300	$300	$1.00	(a)	.....	.....	47,368	$36,083	$0.76
1907	14,000	14,350	1.025	(a)	.....	.....	72,639	60,757	.84
1908	8,000	6,000	.75	(a)	.....	.....	72,741	48,590	.67
1909	5,300	2,783	.525	(a)	.....	.....	81,982	46,777	.57
1910	4,700	2,585	.55	(a)	.....	.....	90,516	39,309	.43
1911	26,152	17,566	.67	2,392	$1,674	$0.70	93,861	53,372	.57
1912	52,508	39,875	.76	8,998	6,400	.71	94,262	63,507	.67
1913	54,198	41,838	.77	17,302	12,136	.70	81,993	63,641	.78
1914	b91,409	81,205	.89	22,723	20,241	.89	(c)	.....	.....
1915	91,415	108,443	1.19	10,624	12,057	1.13	(c)	.....	.....
1916	135,212	210,931	1.56	22,176	27,942	1.26	(c)	.....	.....
1917	207,408	305,097	1.47	50,169	70,939	1.41	(c)	.....	.....
1918	127,164	188,203	1.48	51,702	70,315	1.36	(c)	.....	.....
1919	99,939	121,926	1.22	31,197	37,436	1.20	(c)	.....	.....
	917,705	1,141,102	.....	217,283	259,140	.....	.....	.....	.....

a No production.
b Exclusive of 4,225 pounds of cadmium in residues sold for export.
c No figures showing the cadmium production in Germany later than 1913 are available.

CONDITION OF CADMIUM INDUSTRY.

The highest average annual price recorded for cadmium produced in the United States was $1.56 a pound, in 1916. This greatly stimulated production, and in 1917 the maximum output, 207,408 pounds, a considerable overproduction, was reached. The market for cadmium was not good in the first half of 1918, and stocks were further increased, amounting on August 1, 1918, to 161,000 pounds. Production had been somewhat curtailed before August but was more sharply curtailed thereafter, for the production during the first eight months of 1918 was 118,700 pounds, whereas during the last four months it was only 8,464 pounds. During 1919 the output was still further curtailed, being less than half the production in 1917. The consumption in 1919, however, was about the normal established in 1916 and 1917, exceeding the production very considerably and operating to absorb the surplus stock.

SOURCES.

There are several cadmium minerals, but none of them occur in profitable quantities as ores. The cadmium of commerce is derived from zinc minerals and ores, in almost all of which it occurs in minute quantity, the ratio being about 1 of cadmium to 200 of zinc. Cadmium behaves metallurgically almost the same as zinc and hence constitutes a fraction of 1 per cent of almost all metallic zinc. The sources of cadmium that have been utilized are zinc ores treated by fractional distillation, lead-furnace bag-house "fumes," and residues from the purification vats of electrolytic zinc plants and lithopone plants. These sources and their possibilities as to cadmium yield were discussed in some detail in the chapter on cadmium in Mineral Resources for 1918.

RESOURCES.

In 1918 a canvass was made of lead smelters, electrolytic zinc reduction and refining plants, lithopone plants, and a few typical brass works, with the object of ascertaining the yearly recovery of cadmium in fumes and residues, the accumulated stocks of such materials, and the maximum yearly capacity of the cadmium-reduction plants. Completeness can not be claimed for the results, but fairly detailed replies were received from the larger producers. Little attention has been paid to the cadmium content of fumes and residues, especially by the operators of plants where it accumulates in small quantity.

According to the data obtained, cadmium is accumulating at lead smelters at the rate of 350 to 400 short tons annually, and the stocks of bag-house fumes contained more than 750 tons of cadmium. At electrolytic zinc plants about 200 tons is accumulating annually and the stocks of residues contained about 400 tons. At lithopone plants probably 50 tons is produced yearly and about 25 tons was contained in stocks. In round numbers, then, 600 short tons accumulates annually, and there was on hand approximately 1,200 tons in stocks of fumes and residues. Not all the stocks are rich enough for the cadmium to be commercially recovered, but perhaps material that carries 1,000 tons is suitable for treatment. The average recovery of cadmium is about 75 per cent. We may therefore estimate 750 tons of recoverable cadmium in residues in stock. As the production of cadmium was strongly curtailed in 1918 and 1919, it is probable that these stocks have increased somewhat since the canvass was made in 1918.

REDUCTION CAPACITY.

The maximum capacity for metallic cadmium reported by producers is 29,000 pounds a month, or about 175 tons a year. If the price of cadmium and the demand for it should justify expansion, the producing capacity could no doubt be brought up with reasonable promptness to 500 short tons or more yearly. The price of cadmium will be the deciding factor also in determining what grade of cadmium fumes can be worked at a profit.

IMPORTS.

Cadmium was imported into the United States, before the war, as metallic stick cadmium and as the pigment, cadmium sulphide. The former is free of duty; the latter is dutiable at 30 per cent ad valorem. The value of the imports for consumption of metallic cadmium from 1903 to 1919, inclusive, is given in the table below, which is taken from the records of the Bureau of Foreign and Domestic Commerce. The quantities are not there recorded prior to July, 1909, and for the period preceding that time they have been computed by dividing the values of the imports by the average price of cadmium for the corresponding year in Germany, from which the cadmium was imported. The quantity and value of cadmium imported as a pigment are not recorded separately by the Bureau of Foreign and Domestic Commerce.

Cadmium imported and entered for consumption in the United States, 1903–1919.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1903	[a] 8,679	$4,565	1911	5,367	$3,870
1904	[a] 7,655	4,524	1912	5,250	3,764
1905	[a] 8,138	5,298	1913	1,656	1,232
1906	[a] 13,808	10,522	1914	441	368
1907	[a] 1,953	1,633	1915	269	284
1908	[a] 3,567	2,390	1916	.....	.....
1909 first half	[a] 6,659	4,559	1917	.....	.....
1909 second half	2,203		1918	.....	.....
1910	4,060	2,295	1919	.....	.....

[a] Prior to July, 1909, the quantities are computed as noted above.

EXPORTS.

Statistics of the exports of cadmium are not available, but it is known that domestic cadmium was largely exported during the war. A special investigation by the Bureau of Foreign and Domestic Commerce showed that the following quantities of cadmium were exported through the port of New York in the last quarter of 1916: In October, 33,244 pounds,valued at $55,259; in November, 4,900 pounds, valued at $5,100; and in December, 1,044 pounds, valued at $1,530. Of the exports in October, 23,210 pounds went to France, 9,984 pounds to Italy, and 50 pounds to Dutch Guiana.

Between February 1, 1918, and January 31, 1919, 42,320 pounds of metallic cadmium, valued at $63,020, or an average of $1.49 a pound, was licensed for export to countries listed below, according to information furnished the War Trade Board. Of this quantity, 26,734 pounds was licensed for export before June 30, 1918, and 15,586 pounds between July 1 and December 10, 1918. It is believed that practically all of this cadmium was really exported.

Cadmium and its alloys were taken off the conservation list for practically all countries in December, 1918, so that there is little record of licenses for export in 1919 and consequently little information regarding actual exports of cadmium.

Cadmium licensed for export, Feb. 1, 1918–Jan. 31, 1919.

Destination.	Quantity (pounds).	Value.
Canada	3,025	$4,094
France	30,440	47,960
Great Britain	2,005	2,612
Italy	110	260
Norway	6,740	8,094
	42,320	63,020

Cadmium residues have also been exported, as noted on page 2.

PRICES AND VALUE.

In 1875 cadmium was quoted in the United States at $3.20 a pound. In 1886 the average price for the total output of Germany was 80 cents a pound, but in 1890 and 1892 it fell to 38 cents. In 1897, because of certain purchases by the German Government, the price rose to $1.23 a pound. In 1906, when the United States began making cadmium, the German average price was 76 cents. The price in the United States went down to 53 cents in 1909 and to 55 cents in 1910, when it was 43 cents in Germany. Afterward the price steadily rose in the United States to $1.56 a pound in 1916, dropping off to $1.22 a pound in 1919.

The price quoted for cadmium in sticks and small bars in the first two months of 1919 was $1.50 a pound; for the next four months it was $1.40 a pound; through the third quarter of the year the price ranged from $1.40 to $1.50 a pound; and during the last quarter it was practically constant at $1.40 a pound. Cadmium sales are so irregular, however, that the quotation is "nominal" much of the time. The average price for 1919 as calculated from sales was $1.22, compared with $1.48 in 1918 and with $1.47 in 1917. The average selling price of cadmium sulphide in the United States in 1919 was $1.20 a pound, as compared with $1.36 in 1918 and with $1.41 in 1917.

The value of the output of cadmium in the United States in 1919, calculated at the average selling price, was $121,926, as compared with $188,203 in 1918, and the value of the cadmium sulphide produced was $37,436, as against $70,315 in 1918.

The total value of the output of metallic cadmium in the United States since the beginning of production in 1906 is $1,141,102 and of cadmium sulphide, $259,140, a total of $1,400,242.

USES.

Cadmium is used in metallic form chiefly in alloys, and its various salts are used in the arts, in medicine, and in electroplating.

MISCELLANEOUS CADMIUM ALLOYS.

Cadmium lowers the melting point of alloys in which it is used and is therefore extensively employed in making easily fusible

alloys and soft solders, such as those used in the fusible plugs of automatic sprinkler systems. It is also used in making fusible safety plugs for boilers and electric fuses. Cadmium cliché metal is superior to the corresponding bismuth cliché metal for making stereotype plates.

An Austrian patent solder for aluminum (patent 71088–1916) consists of 13 parts of cadmium, 1 part of tin, and 6 parts of zinc.

When the price of zinc was so high in the early part of the war there was some substitution of lead-coated sheets for galvanized sheets. Lead, however, does not adhere readily to iron. The use of a small quantity of cadmium in the lead, less than 1 per cent, makes it possible to cover the iron with a very thin coat or film of lead.

CADMIUM AS A SUBSTITUTE FOR TIN IN SOLDERS.

When tin was so scarce in the first three-quarters of 1918, there was a general reduction of the quantity of tin in all solder formulas in order to conserve tin and there was an increased use of cadmium as a sustitute for tin in solders, such as the half-and-half lead-tin solder. Though cadmium was worth much more than tin it could be profitably substituted for all or a part of the tin in solders because less cadmium than tin and consequently more lead was used. Moreover, the tin supply was needed for uses for which it had no possible substitute.

In the last year of the war the Government and certain large concerns began studies of cadmium solders as a means of conserving the tin supply. The results of these studies were encouraging, but the demand for tin decreased and the armistice was signed before this use of cadmium attained much commercial importance.

About 600 tons of cadmium accumulates annually in this country as dusts and residues, by-products of the lead and zinc industries, and about 100 tons of metallic cadmium is recovered from these by-products. If all the cadmium dusts and residues were treated, the output of metallic cadmium would be small in comparison to the 19,000 or 20,000 tons of tin annually used in this country in solder, even if due allowance is made for the fact that 1 pound of cadmium can replace from 3 to 5 pounds of tin. Various formulas proposing the substitution of cadmium for tin in solders are given in the chapter on Cadmium in Mineral Resources for 1918. On the whole, American experience with cadmium solders is promising, and their use for certain purposes seems fairly established.

It was reported early in the war that the Germans, without resources in tin but with a fair supply of cadmium, were substituting that metal for tin. It is now known that solders with 10 per cent of cadmium and 10 per cent of tin were used, and that the cadmium content in others ranged as high as 30 per cent, with 2 per cent of tin. It is not likely that much solder from the latter formula was made, however, because Germany's cadmium production is not normally larger than that of the United States, and this production could hardly have expanded unduly as in the main it must bear a certain relation to the output of zinc, something like 0.04 per cent.

In view of American experience, as given above, the following view of German experience as given in the (London) Mining Journal, of January 3, 1920, page 3, is interesting:

Tin solder substitutes.—In view of a probable continuance of the tin shortage in Germany, an article in the Metallbörse discusses the possibility of discovering suitable solder substitutes. During the war a considerable reduction in the proportion of tin in soft solders was permitted, and such tin as was used was not taken from fresh ingots, but was obtained from waste, ashes, and scrap. The proportion of tin varied between 25 per cent and 40 per cent; that of lead was considerably increased, and careless manufacture often produced harmful results. Cadmium alloys, which as a rule are only used for very low smelted solders, came greatly into favor, but such substitutes as this have no particular durability. Cadmium solder may be suitable in theory, but for most practical purposes it is useless. The employment of solder substitutes in the gas-meter industry has proved a failure, resulting in cracking on cooling, splitting on the slightest tension, and leaks in the seams of plates, etc. For dry gasometers antimony solder may be used with advantage, but in all other cases the employment of substitutes for tin has led to endless difficulties.

WAR USES.

The war interest in cadmium centered mainly in its use as a substitute for tin, but its greatest war use was probably in bronze telegraph and telephone wires, which seems likely to be its greatest peace-time use also.

Cadmium and cadmium compounds were declared contraband of war by nearly all the belligerents, hence they must have military uses, but naturally there is not much authoritative information about these uses. Cadmium is said to have been used in smoke bombs for signaling. It is reported that relatively large quantities of cadmium were exported to Germany before the war for use in making small-arms ammunition. A cadmium band on the hard-jacketed cartridge ball is said to take the rifling with little wear on the barrel and thus prolong the life of the gun.

A fraction of 1 per cent of cadmium is used as a deoxidizer in making bronze telegraph and telephone wires and cables in France and Italy. It is reported that such cables heavily charged with electricity were used in the wire entanglements before the trenches at the front. Cadmium is also used as a deoxidizer in making nickel alloys and may serve a like purpose in making brass.

Italy, France, Belgium, and Great Britain have avowed the policy of electrifying their steam transportation systems as soon as feasible. In view of the European use of cadmium in trolley wires such electrification would seem to promise a very considerable demand for cadmium in the next few years, the bulk of which must be supplied by the United States, as the cadmium industry of Upper Silesia, the main European source of the metal, will probably be more or less disorganized for several years to come.

SALTS OF CADMIUM.

The sulphide of cadmium is the brilliant pigment cadmium-yellow or jaune brillant. Properly prepared it is one of the most permanent pigments known, and it is unaffected by hydrogen sulphide gas from coal smoke, whereas the common yellow pigments (lead chromes) are blackened in a smoky atmosphere. Cadmium-yellow is therefore employed as a protective coating over chrome-yellow in painting street cars and the passenger coaches on some railway lines.

Sulphide of cadmium is extensively used to give color and luster to glass and porcelain, and other cadmium salts are used in dentistry, dyeing, and photography.

Cadmium electroplating is a field that offers some promise of expansion. Cadmium is a better rust preventive than nickel, and at more nearly a parity in prices cadmium plating might be substituted for nickel plating in some cases. Or, since it has a greater tendency to tarnish than nickel, it might be used in combination with nickel, the first coat consisting of the rust-preventive cadmium and the second coat of the tarnish-proof nickel.

BIBLIOGRAPHY.

A list of the books and more important articles on cadmium which have appeared in recent years is given in the chapter on cadmium in Mineral Resources for 1918.

PLATINUM AND ALLIED METALS.

By James M. Hill.

DOMESTIC PRODUCTION.

CRUDE PLATINUM.

Owing to the fact that the statistics of the production of mines for the calendar year 1919 are being collected in cooperation with the Bureau of the Census, Department of Commerce, no authentic data are available at this date (Apr. 30, 1920) concerning the output of crude platinum by the mines in the Western States.

It is known that approximately 683 ounces of crude platinum from mines in California, 119 ounces from mines in Oregon, and 22 ounces from mines in Alaska—a total of 824 ounces—was purchased by refiners in 1919, indicating an increased production of crude platinum by domestic mines, which produced 647 ounces in 1918.

REFINED PLATINUM METALS.

NEW METALS.

Reports received from refiners of platinum, gold bullion, nickel, and copper indicate that 45,109 troy ounces of refined new metals of the platinum group was recovered in 1919, a decrease of 14,644 ounces, or 25 per cent, from the new metals recovered in 1918. About 11,759 troy ounces of the new metals recovered in 1919 is believed to have been derived from domestic materials.

New platinum and allied metals recovered by refiners, 1915–1919, in troy ounces.

Year.	Platinum.	Iridium.	Iridosmine-osmiri-dium.	Palladium.	Rhodium.
1915	6,495	274	355	1,541	.....
1916	24,518	370	315	2,885	.....
1917	33,009	210	833	4,779	.....
1918	54,399	465	539	4,024	326
1919	40,220	401	402	3,807	279

Some of the platinum recovered and reported, particularly by gold and copper refiners, is probably obtained from scrap material, though there is no way in which this quantity can be determined, as the platinum metals are recovered only after a considerable length of time and from the slimes obtained from treatment of all the material passing through the electrolytic process.

The figures include recoveries in domestic plants of all foreign and domestic material. Thus, the recovery of platinum and palladium

from the Sudbury nickel mattes is included in the figures of total recovery, but not in the figures of platinum metals that are believed to be of domestic origin (11,759 troy ounces).

SECONDARY METALS.

By secondary metals are meant those metals which are recovered by refining scrap metals, sweepings, and all waste products of manufacture that contain the platinum metals. The quantities reported undoubtedly cover some duplication, as platinum metals may be recovered from scrap several times in a year. Yet it is believed that information on this subject is of great importance, for the yearly output of new refined metals is not sufficient to meet the demand, which, therefore, must be supplied by reworking waste material of all kinds. Refiners report recoveries in 1919 of 61,516 ounces of secondary platinum metals, distributed as shown below.

Secondary platinum and allied metals recovered, 1915–1919, in troy ounces.

Year.	Platinum.	Iridium.	Palladium.
1915	42,149	863	958
1916	45,156	1,535	1,284
1917	59,007	9,832	3,347
1918	40,378	3,410	1,795
1919	54,545	3,504	3,467

The increase of 35 per cent over the recoveries in 1918 can be attributed to the great demand from jewelers, which was largely met from secondary metals.

IMPORTS.

The imports of platinum and allied metals for consumption in 1919, as given by the Bureau of Foreign and Domestic Commerce, were approximately 20 per cent more than those in 1918, practically as large as in 1915, and more than half as large as the prewar imports, which averaged about 110,000 ounces.

Platinum and allied metals imported for consumption in the United States, 1918 and 1919.

Metal.	1918		1919	
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.
Platinum or crude platinum and unmanufactured products, ingots, bars, sheets, wire	54,963	$4,949,855	54,550	$5,229,309
Platinum, manufactured products, vases, retorts, etc.	(a)	8,597	22	b 17,213
Iridium	1,126	126,282	5,808	975,174
Osmiridium	427	46,321	1,374	112,403
Osmium			2,339	132,097
Palladium	240	36,853	3,739	250,777
Rhodium			222	30,474
	56,756	5,167,908	68,054	6,747,447

a Quantity not given.
b Includes wire to the value of $11,720 imported under 15 per cent duty, quantity not given, and "all other" to the value of $2,821, quantity not given.

Platinum imported into the United States, 1918 and 1919.

	Unmanufactured.		Ingots, bars, etc.		Manufactured products, vases, etc.	Total value.
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.		
1918.[a]						
France	376	$39,006				$39,006
England	193	17,948	202	$19,910	$11,458	49,316
Netherlands					433	433
Canada	75	7,924	200	20,978	[b] 1,634	30,536
Costa Rica			3	500		500
Panama	471	43,439	872	75,040		118,479
Cuba			6	575		575
Brazil	27	2,312				2,312
Chile	142	12,099				12,099
Colombia	22,974	1,973,090	7,569	657,524	[b] 700	2,631,314
Dominican Republic			3	214		214
Peru	3	300				300
Ecuador			2	219		219
Venezuela	16	1,610	8	438		2,048
China	423	34,267				34,267
Dutch East Indies	21	1,339				1,339
Japan	112	11,406	228	26,251		37,657
Russia in Asia	21,000	2,000,000				2,000,000
British South Africa			36	3,366		3,366
	45,833	4,144,740	9,129	805,015	14,225	4,963,980

	Unmanufactured.		Ingots, bars, plates, etc.		Vases, retorts, etc., for chemical use.		All other platinum.	Total value.
	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.	Quantity (troy ounces).	Value.		
1919.								
France	4,959	$514,197	454	$49,218			$2,737	$566,152
Netherlands			5	446	1	$489		935
Spain			65	6,825			84	6,909
England	17,554	1,793,276	3,431	382,324	10	1,046	11,720	2,188,366
Canada	72	7,419	106	9,889	11	1,137		18,445
Panama	1,032	84,902						84,902
Mexico			2	210				210
Jamaica			2	175				175
Cuba	43	5,210						5,210
Brazil	33	2,997						2,997
Colombia	23,585	2,087,061	2,461	216,150				2,303,211
Peru	12	961						961
Uruguay	4	420						420
Venezuela	16	1,683	2	100				1,783
China	84	8,355	45	4,700				13,055
British India			2	200				200
Japan	80	6,979	1	112				7,091
Russia in Asia	400	35,000						35,000
Australia	44	5,400						5,400
New Zealand	2	206						206
British South Africa	27	2,287	27	2,607				4,894
	47,947	4,556,353	6,603	672,956	22	2,672	14,541	5,246,522

[a] Does not include platinum manufactures "not specially provided for" in the tariff act, upon which a duty of 50 per cent is imposed.
[b] Six months, January to June.

As will be seen from the preceding table, Colombia continues to be our chief source of supply for crude platinum. England and France, however, contributed 26,398 ounces during 1919, most of which was presumably refined metal.

EXPORTS.

Exports of platinum reported by the Bureau of Foreign and Domestic Commerce in 1919 were 522 ounces of unmanufactured platinum, valued at $75,066, and manufactures of platinum to the value of $54,529.

CONSUMPTION.

Two methods of calculating the consumption of platinum in the United States are available. One, followed in the report for 1918, is the tabulation of information supplied by dealers and refiners. The following table, giving the results of this method for the years 1918 and 1919, is of particular value, as it shows the consumption by industries.

Platinum metals used in the United States in 1918 and 1919 by consuming industries, in troy ounces.

Industry.	Platinum.	Iridium.	Palladium.	Total.	Percentage of total.
1918.					
Chemical	45,391	717	834	46,942	41
Electrical	24,982	3,107	594	28,683	25
Dental	11,461	418	7,371	19,250	17
Jewelry	13,541	721	42	14,304	12
Miscellaneous	5,435	339	212	5,986	5
	100,810	5,302	9,053	115,165	100
1919.					
Chemical	10,759	41	63	10,863	7
Electrical	23,875	3,534	1,283	28,692	19
Dental	11,047	185	10,311	21,543	14
Jewelry	82,397	3,145	1,460	87,002	56
Miscellaneous	5,602	596	445	6,643	4
	133,680	7,501	13,562	154,743	100

This table shows that whereas during the war the essential industries, chemical, electrical, and dental, used 83 per cent of the platinum metals consumed, in 1919 they used only 40 per cent; on the other hand, the jewelry industry, which in 1918 was permitted to use only 12 per cent of the supply, in 1919 consumed 56 per cent. It is believed that the figures for consumption in 1919 are more nearly normal and give a fair measure of the platinum industry under ordinary conditions, though it is probable that the consumption by jewelers was a little above the average.

The second method of computing the apparent consumption is given in the following table. This is the first year in which the data necessary for such a table have been available. It will be noted that several assumptions must be made, as the statistics of imports and exports of the Bureau of Foreign and Domestic Commerce are not susceptible of exact interpretation as to the character of materials imported, and in some items quantities are not given.

Platinum metals consumed in the United States in 1919, in troy ounces.

	Platinum.	Iridium.	Palladium.	Total.
Stocks on hand Dec. 31, 1918 (unmanufactured and manufactured)	51,504	3,224	10,086	64,814
Production, new metals, 1919	40,220	401	3,807	44,428
Production, secondary metals, 1919	54,545	3,504	3,467	61,516
Imports[a]	19,939	5,808	3,739	29,486
Total available for consumption	166,208	12,937	21,099	200,244
Stocks on hand Dec. 31, 1919 (unmanufactured and manufactured)	29,228	3,359	10,235	42,822
	136,980	9,578	10,864	157,422
Exports[b]	1,000	.....	.....	1,000
Apparent consumption	135,980	9,578	10,864	156,422

[a] The figures used above include imports of manufactured platinum, iridium, and palladium, and a figure which is the difference between the item in the first column of the table on page 12 and the quantity of crude platinum that refiners report they used during 1919. This difference has been interpreted as representing imports of refined platinum. There is also added 122 ounces of manufactured ware which has been included under platinum, though this material may have contained some iridium.

[b] Exports not given in quantity for all classes by Bureau of Foreign and Domestic Commerce; estimated as 1,000 ounces of platinum.

It will be noted that the total quantity of platinum metals consumed as calculated above—156,422 ounces—is very close to 154,743 ounces, the figure arrived at by the first method of computation. It is therefore entirely reasonable to assume that the consumption of platinum metals in the United States in 1919 was approximately 155,000 ounces.

STOCKS OF PLATINUM METALS.

Refiners and dealers in platinum metals reported stocks of 43,432 ounces on December 31, 1919, as compared with 64,814 ounces on December 31, 1918.

Stocks of platinum metals on hand Dec. 31, 1918 and 1919, in troy ounces.

Metal.	Unmanufactured.	Manufactured articles.	Total.
1918.			
Platinum	17,740	33,764	51,504
Iridium	2,259	965	3,224
Palladium	7,141	2,945	10,086
	27,140	37,674	64,814
1919.			
Platinum	21,720	7,508	29,228
Iridium	2,970	389	3,359
Palladium	8,540	1,695	10,235
Other	42	568	610
	33,272	10,160	43,432

There is some question as to the accuracy of the figures in these tables; it is certain, however, that they reflect the trend of affairs. It must be admitted that we are drawing heavily on supplies that are not adequate and that probably will not be adequate for some years, at least. The stocks of iridium and of palladium are nearly the same for 1918 and 1919, but the stocks of platinum have been lowered about 43 per cent.

The stocks on hand December 31, 1919, represent supplies of about 22 per cent of the platinum, 45 per cent of the iridium, and 75 per cent of the palladium that will be consumed in 1920 if the rate of consumption remains the same as in 1919. However, the rate of consumption is probably increasing, so that the adequacy of the stocks is questionable.

MARKET AND PRICES.

REFINED METALS.

The market price for platinum in January, 1919, was $100 to $106 an ounce. The price continued to decline through April to a low of about $99 an ounce. This decline may have been due in part to easier conditions during the sale of Government surplus stocks. The last of April prices began to stiffen, and by the middle of May they reached $105 an ounce, which was about the average price until the middle of August. Owing to the great demands of the jewelry industry and the shortness of supplies late in the summer, prices rose rapidly to $135 an ounce in September and reached a maximum of $155 an ounce in December.

The price for palladium at the beginning of the year was $125 an ounce, which dropped to a low of $115 an ounce in February but reacted to $120 early in March, and remained practically stationary throughout the remainder of the year.

Iridium is not ordinarily quoted. The supply of this metal has been extremely short, and it is understood that more than $300 an ounce was paid during the year.

Average prices of platinum per troy ounce in the New York market, 1913–1919.[1]

1913	$44.88	1919—Continued.	
1914	45.06	May	$102.60
1915	49.63	June	105.80
1916	83.40	July	105.90
1917	102.82	August	107.60
1918	105.95	September	128.70
1919:		October	132.21
January	104.85	November	136.74
February	100.43	December	151.35
March	99.20		
April	99.85	Average, 1919	114.60

The prices reported to the United States Geological Survey by refiners of the platinum group of metals varied considerably in 1919. In the following table fair average prices are given, and these prices have been used by the Geological Survey in all computations.

Average price per troy ounce of refined metals of the platinum group, 1914–1919.

Metal.	1914	1915	1916	1917	1918	1919
Platinum	$45	$55	$84	$103	$105	$123
Iridium	65	83	94	150	175	255
Iridosmine	33	35	45	80	90	105
Palladium	44	56	67	110	135	130

[1] Eng. and Min. Jour., vol. 109, p. 112, 1920.

CRUDE PLATINUM.

The miners of California, Oregon, and Alaska received from $63 to $108 an ounce for their crude platinum in 1919, the average price being about $72 as compared with $91 for 1918. Prices reported by refiners as paid for foreign crude platinum varied from $76 to $140, the average being about $100 an ounce. The principal buyers of foreign and domestic crude platinum in the United States during 1919 are listed below:

American Platinum Works, Newark, N. J.
Baker & Co. (Inc.), Newark, N. J.
David Belais, 13 Dutch Street, New York, N. Y.
J. Bishop & Co., Malvern, Pa.
Sigmund Cohn, 44 Gold Street, New York, N. Y.
Goldsmith Bros. Smelting & Refining Co., 20 John Street, New York, N.Y.
Kastenhuber & Lehrfeld, 24 John Street, New York, N. Y.
Pacific Platinum Works, Los Angeles, Calif.
R. & H. Platinum Works, 709 Sixth Avenue, New York, N. Y.
Shreve & Co., San Francisco, Calif.
Wildberg Bros., San Francisco, Calif.
H. A. Wilson Co., Newark, N. J.

WORLD'S PRODUCTION.

Statistics of the world's production of platinum and allied metals are at best estimates, though they are derived from the most reliable information obtainable.

Estimated world's production of crude platinum, 1911–1919, in troy ounces.

Country.	1911	1912	1913	1914	1915	1916	1917	1918	1919
Borneo, India, and Sumatra	.....	.....	200	(a)	b 18	b 9	c 52	(a)	(a)
Canada	30	30	50	30	100	60	80	30	30
Colombia	12,000	12,000	15,000	17,500	18,000	25,000	32,000	35,000	35,000
New South Wales and Tasmania	470	778	1,500	1,248	303	222	330	d 1,606	d 1,326
Russia	300,000	300,000	250,000	241,200	124,000	63,900	50,000	25,000	30,000
United States	628	721	483	570	742	750	605	647	824
	313,128	313,529	267,233	260,548	143,163	89,941	83,067	62,283	67,180

a No basis for estimate.
b India only.
c Dutch East Indies and India.
d Tasmania only.

NOTES ON PLATINUM DEPOSITS.

UNITED STATES.

The Boss mine, Clark County, Nev., produced platinum and palladium-bearing copper ore in 1919 which was shipped to eastern refiners for treatment It is reported that a new body of this ore was opened by development during 1919. The Salt Chuck mine, Kasaan, Alaska, continues to ship very rich palladium-bearing concentrates. The Rambler mine, Albany County, Wyo., also shipped platinum and palladium-bearing copper ore.

Little can be said concerning the operations of the placers in Oregon and California that produce platinum, in view of the delay in obtaining returns from the mines. So far as known no particular change is to be recorded in the source of crude platinum, the dredges along the foothills of the Sierra Nevada still being the largest producers.

OTHER COUNTRIES.

CANADA.

No information is available concerning new developments in the platinum placer fields of western Canada. The Port Colburn refinery of the International Nickel Co. is reported [2] to have produced about 25 ounces of platinum and 62 ounces of palladium in an impure state, mixed with gold and silver. Presumably this is in addition to the platinum and palladium recovered by the American refinery of this company, whose output is included in the figures of production of domestic refiners.

COLOMBIA.

According to information supplied by the Bureau of Foreign and Domestic Commerce, Department of Commerce, 26,046 ounces of platinum was imported from Colombia in 1919, which is 4,497 ounces less than the reported imports in 1918. However, American refiners of platinum report that during 1919 they purchased more than 34,000 ounces of Colombian crude platinum.

Additional delays made it impossible to put the new dredge of the South American Gold & Platinum Co. into commission in 1919, though it was believed that this boat should be digging early in 1920. This company was refinanced during 1919, issuing $500,000 of 7 per cent convertible income notes and 2,000,000 shares of common stock, par value $5. The Lewisohn interests of New York, the Consolidated Gold Fields of South Africa, the Gold Fields American Development Co. (Ltd.), and Johnson, Matthey & Co. (Ltd.), London, control the majority of this stock.

The British interests in the Paris (Transvaal) Gold Mines and the British Platinum & Gold Corporation (Ltd.) have been consolidated and are now operating under the latter name. The new company is capitalized at £1,000,000. Early in 1920 it was announced [3] that 5,000,000 cubic yards of dredgeable ground carrying 2s. (50 cents) to the yard and 60,000,000 yards of hydraulic ground had been proved, having a value of more than £1,700,000, 75 per cent of which is in platinum and 25 per cent in gold. This company proposes to work on Opogodo and Condoto rivers, tributaries of the San Juan, and controls 300 square miles of property.

It is interesting to note that platinum is now being saved by the dredges on Nechi River, a tributary of the Magdalena, in north-central Colombia. The annual report of the company [4] states that platinum having a value of £225 8s. 3d. was recovered, which would indicate about 15 ounces for the year.

The movement started in 1919 by Senator Escobar, of the Colombian Congress, to nullify certain mineral concessions held by foreigners in various parts of Colombia has apparently failed.

RUSSIA.

No authentic news is available concerning the Russian platinum field. In March, 1919, the Omsk Government controlled the sale of the platinum produced in the territory over which it had control.

[2] Canadian Min. Jour., p. 190, Mar. 12, 1920.
[3] Min. Jour. [London], Jan. 3, 1920, pp. 14–15.
[4] Min. Jour. [London], vol. 125, p. 420, 1919.

This territory was occupied by the soviet government in July and has been under soviet rule since. If newspaper accounts are to be credited, a considerable quantity of platinum must be held by the soviet government, which has proposed to issue $67,000,000 in rubles, secured by platinum valued at $35,000,000, to be used for purchases in foreign countries.

According to a statement of the soviet representative in the United States,[5] the production of platinum during the last few years is as shown below:

Platinum reported as produced in Russia, 1910–1918.

Year.	Poods.[a]	Troy ounces.
1910	335	176,426
1911	352	185,379
1912	337	177,479
1913	299	157,467
1914	298	156,940
1915	206	108,489
1916	150	78,997
1917	187	98,483
1918 (to July 1)	25	13,166

[a] 1 pood = 526.645120 troy ounces.

Unconfirmed reports state that platinum deposits are now being worked on the Alai Mountains, in Ferghana, Turkestan. These deposits are said to have been discovered by German prisoners of war.

It has also been reported that some platinum is found in the gold placers of the Marinsk district, Tomsk Government, in the Vozdvihensk, a tributary of Chumiya River, and in the Bolehich-Chelnloff, a tributary of Kiu River.

In the Bisk Government platinum has been reported from the gold placers of Tzarevo-Alexandravsk and Kochina rivers.

TASMANIA.

According to official reports [6] the production of osmiridium from Tasmania is as follows:

Osmiridium produced in Tasmania, 1910–1918.

Year.	Troy ounces.	Value per ounce.
		£ s.
1910	120	4 8
1911	271	4 7
1912	778	7 7
1913	1,261	9 10
1914	1,081	9 17
1915	247	6 8
1916	222	8 11
1917	332	14 15
1918	1,606	7 18

The production for 1919 [7] is stated to be 1,325.89 troy ounces, the output for the last quarter being estimated.

[5] Russian Economic League (Woolworth Building, New York City) Bull. 8, p. 6, December, 1919.

[6] Brown, Campbell, A review of the osmiridium mining of Tasmania: Tasmania Sec. Mines Rept. for 1918, pp. 133-144, 1919.

[7] Australian Ind. and Min. Standard, vol. 63, Jan. 1, 1920.

Late in 1918 the price paid locally for Tasmanian osmiridium was reported at £14 to £15 an ounce, but apparently it rose during the summer so that as much as £33 an ounce was reported as paid during the later part of 1919. Tasmanian osmiridium has apparently been purchased on a very irregular basis. It would seem that purchases based on iridium content might be more satisfactory, as the iridium content of the osmiridium from various localities ranges from 33 to 58 per cent.

The principal osmiridium fields are on Savage River, Jones Creek, Mount Stewart, and Wilson River, in northwestern Tasmania. The Mount Stewart field was discovered in 1917 and much rich ground was worked out. Deposits in Castro Valley appear to hold considerable promise. Work in this field is limited to the winter season, when water is available. The Savage River district can be worked only in the dry period of summer.

An investigation of the osmiridium fields of Tasmania is planned for 1920 by the Geological Survey of Tasmania.

BRITISH GUINEA (PAPUA).

Brown [8] states in his report that the placers of Papua (British New Guinea) may outrival the Tasmania placers as producers of osmiridium. Little detailed information is available concerning the geology of Papua, though it is known that there is much serpentine on the island and that osmiridium has been found in the gold placers of the Lakekama district and the Yodda Valley. Labor is scarce in Papua, and living conditions are not of the best. It would appear that this is a possible source of iridium which should be investigated in view of the present shortage of this very necessary metal.

REFERENCE WORKS ON PLATINUM.

The attention of those who are interested in the platinum industry should be called to two works of unusual value recently issued.

Dr. Louis Duparc, the noted European authority on platinum, has prepared an elaborate work on the geology, mining, and metallurgy of the platinum metals. This work, "Le platine et les gîtes platinifères de l'Oural et du monde," from the press of the Société anonyme des éditions "Sonor," 46 rue du Strand, Geneva, Switzerland, was to have been ready March 1, 1920, though the writer has not yet seen it in the United States. Undoubtedly Duparc's book will be well worth close study, for it represents the life work of an eminent scientist who has had ample opportunity to study his subject.

Dr. James Lewis Howe, of Washington and Lee University, Lexington, Va., has brought his earlier bibliography [9] up to date. Happily the United States Geological Survey was privileged to publish this valuable reference book as Bulletin 694. This work will be particularly valuable to those who are interested in the chemistry of platinum metals, for it includes references to papers dealing with every phase of the platinum industry, wherever published, as well as author and subject indexes.

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[8] Brown, Campbell, op. cit.

[9] Bibliography of the metals of the platinum group, 1748–1896: Smithsonian Misc. Coll. 1804, 1897.

ARSENIC.

By James M. Hill.

PRODUCTION.

The white arsenic produced in the United States in 1919 amounted to 6,029 short tons. This was a slight decrease from the output in 1918, which was 6,323 short tons, valued at $1,213,000. Besides producing white arsenic one company reported that it produced metallic arsenic.

The table below shows the production of white arsenic from the beginning of the industry in this country.

White arsenic (As_2O_3) produced in the United States, 1901–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1901	300	$18,000	1911	3,132	$73,408
1902	1,353	81,180	1912	3,141	190,757
1903	611	36,691	1913	2,513	159,236
1904	36	2,185	1914	[a] 4,670	313,147
1905	754	35,210	1915	[b] 5,498	302,116
1906	737	63,460	1916	[c] 5,986	555,187
1907	1,751	163,000	1917	6,151	1,118,313
1908	(d)	(d)	1918	6,323	1,213,000
1909	1,214	52,946	1919	6,029	(e)
1910	1,497	52,305			

[a] This quantity includes 200 tons of crude arsenic trioxide carrying about 97.5 per cent of As_2O_3.
[b] This quantity includes 353 tons of crude arsenic trioxide carrying about 97.5 per cent of As_2O_3.
[c] This quantity includes 152 tons of crude arsenic trioxide carrying about 97.5 per cent of As_2O_3.
[d] Only two firms produced arsenic in the United States in 1908, so that the figures can not be published without disclosing confidential returns.
[e] Only two companies reported production of white arsenic in 1919. Both have given permission to publish figures of quantity but not of value.

The refined arsenic produced is reported to be above 99.5 per cent of As_2O_3.

Ordinarily there are at least four producers of white arsenic in the United States. Owing to the low prices prevailing the Chipman Chemical Co., which, during the last few years, has produced arsenic at its mine near Brinton, Va., found it more advantageous to purchase the arsenic it uses in the preparation of insecticides, weed killers, and sheep dip.

The elaborate Cottrell installation of the Anaconda Copper Co., at Anaconda, Mont., was reported as not producing arsenic during 1919, though the company sold considerable arsenic from stock. It is understood that this installation will recover considerable arsenic during 1920.

During 1919 the White Caps Mining Co., of Manhattan, Nev., marketed crude auriferous orpiment-realgar ore containing 45 per cent of arsenic. It is reported that this company has a considerable quantity of this ore in its mine.

IMPORTS.

The imports of white arsenic in 1919 were more than double the imports during 1918, but the quantity of "arsenic and sulphide of, or orpiment" decreased more than 50 per cent, as is shown by the following table. Our principal imports in 1919 were from Canada, Mexico, and Japan.

Arsenic compounds imported and entered for consumption in the United States, 1909–1919.

Year.	Arsenic or arsenious acid (white arsenic, As_2O_3).		Arsenic and sulphide of, or orpiment.		Sheep dip.		Paris green and London purple.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1909	445	$31,235	3,591	$272,493	1,574	$9,615	183,765	$20,370
1910	1,348	76,282	3,791	238,024	.....	24,279	181,363	14,648
1911	1,921	116,948	2,175	127,375	.....	20,642	126,191	4,972
1912	3,103	200,616	3,053	228,125	.....	41,556	162,272	6,950
1913	1,519	133,597	3,182	276,849	.....	40,036	99,692	4,431
1914	1,594	109,121	2,034	164,592	.....	34,556	15,476	2,235
1915	1,400	113,677	1,783	154,099	.....	19,916	21,056	4,069
1916	1,071	107,876	1,092	124,818	.....	20,134	23,461	5,028
1917	1,178	264,534	2,777	410,341	.....	15,846	48	189
1918	1,847	441,212	4,842	840,600	.....	23,538	.....	.....
1919	4,389	624,494	2,151	316,687	146,803	12,346	18	14

EXPORTS.

Information compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, shows that there were no exports of arsenic in 1919 of either foreign or domestic origin.

Foreign arsenic and sulphide, or orpiment, reexported, 1914–1919.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1914	700	$79	1917	113,600	$15,840
1915	9,776	526	1918	80,050	12,017
1916	1,761	1,256	1919	.....	.....

PRICE.

Quotations[1] for white arsenic at the beginning of the year 1919 were 9 to 12 cents a pound, but in the latter part of February and continuing to the middle of April they changed to 9.5 to 11 cents a pound. In May the price dropped to 9 to 10 cents and in June to 8 to 9 cents a pound. In the middle of July prices began to increase and in September averaged 10¼ cents a pound, but declined to 9¾ cents in October only to rise again to 10¼ cents in November and to 10¾ cents during the latter part of December.

[1] Taken from weekly figures published by Oil, Paint, and Drug Reporter, vols. 95, 96, 1919.

FOREIGN PRODUCTION OF ARSENIC.

The production of arsenic in foreign countries is summarized below. As will be noted, not all of this output is reported as white arsenic.

Australia.—Queensland[2] operated mines and recovery works near Jiblenlow and produced 66 long tons (74 short tons or 67 metric tons) of arsenical pyrite from which white arsenic was produced and sold practically at cost to the farmers for the destruction of "prickly pear," which is a menacing pest in the State.

In western Australia[3] the official reports note the exportation of 679 long tons (760 short or 690 metric tons) of arsenic (form not mentioned but presumably arsenical ore) in 1918, valued at £2,564.

Japan.—Japanese statistics[4] show the production of 65,819 kwan (272 short tons or 246.82 metric tons) of arsenical ore and 354,360 kin (234 short tons or 212.62 metric tons) of arsenious acid. Whether the white arsenic was made from the arsenical ore or from other material is not apparent from the statements made.

Spain.—In Spain[5] works in Corunna and Oviedo produced 104.24 metric tons (115 short tons) of arsenious acid (white arsenic) in 1918.

England.—In England[6] 2,349 long tons (2,631 short or 2,387 metric tons) of white arsenic was produced in 1918.

Rhodesia.—The white arsenic output of Rhodesia[7] in 1918, which was 114 tons, was used locally for the manufacture of cattle dip. In the Transvaal 18 tons of white arsenic was recovered.

Canada.—In Canada[8] 2,545 short tons (2,309 metric tons) of arsenic was recovered by smelters treating cobalt ores.

Greece.—In Grecian works[9] 436 metric tons (481 short tons) of white arsenic was produced in 1917, of which 294 metric tons (324 short tons) was sold.

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[2] Queensland Undersecretary for Mines Ann. Rept., pp. 29, 30, 1918.
[3] Western Australia Dept. of Mines Rept. for the year 1918.
[4] Mining Industry of Japan in 1918, Dept. Agriculture and Commerce, Imp. Bur. Mines, pp. 14, 16, 20, 26, 34, 1919.
[5] Estadística minera de España, Consejo de minería, 1918, Ministerio de Fomento, 1919.
[6] Mines and Quarries General Rept., 1918 (Home Office).
[7] Eng. and Min. Jour., vol. 108, p. 645, 1919.
[8] Ontario Bur. Mines Twenty-eighth Ann. Rept., vol. 28, pts. 1 and 2, p. 2, 1919.
[9] Tableaux statistiques du mouvement minier de la Grèce pendant l'année 1917.

BISMUTH.

By James M. Hill.

PRODUCTION.

In 1919 bismuth was recovered by only one company in the United States, the American Smelting & Refining Co., which obtains this product from the refining of lead bullion. Statistics of production can not be published.

IMPORTS AND EXPORTS.

Bismuth imported for consumption in the United States, 1914–1919.

Year.	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1914	90,505	$165,208	1917	69,250	$142,300
1915	44,362	108,288	1918	135,700	277,273
1916	76,723	195,975	1919	57,607	55,179

No exports of bismuth are recorded.

PRICES.

The prices quoted for bismuth were $3.50 a pound in 500-pound lots during the first half of 1919. In the middle of June a gradual decline in price began, and at the end of the year quotations stood at $2.75 to $2.90 a pound.

FOREIGN PRODUCTION OF BISMUTH.

Bismuth ores are produced largely in connection with tin and tungsten ores. Figures of output of foreign bismuth mines are given as production or exports of ore or concentrates, but as the statistical publications of foreign countries rarely give percentage figures for the material it is difficult to gain an adequate idea of the importance of producing countries.

World's production of bismuth ores and concentrates, 1914–1918, in metric tons.

	1914	1915	1916	1917	1918
Australia:					
Queensland [a]	0.865	2.540	3.607	4.064	21.336
Tasmania [b]	5.709	5.580	3.566	4.279	4.682
Western Australia [c]	.....	1.016	0.254	0.508	.....
Bolivia [d]	349.669	662.565	668.426	534.717	490.072
Japan [e]	(f)	(f)	(f)	(f)	1.666
Peru [g]	11.187	.....	.....	1.357	(f)
Spain [h]	40.45	16.805	10.860	13.900	33.500

[a] Queensland Undersecretary for Mines Ann. Rept. for the year 1918, pp. 29, 30, 1919. (Production reported in long tons.) Also report of export of mixed bismuth-tungsten concentrate, 1917=333.500 metric tons; 1918=116.128 metric tons.

[b] Tasmania Secretary for Mines Ann. Rept. for year ending Dec. 31, 1918, pp. 37, 49. (Production reported in long tons.)

[c] Western Australia Dept. Mines Rept. for 1918, p. 2. (Exports reported in long tons.)

[d] Comercio especial de Bolivia, 1918, Dirección general de aduanas. (Exports reported as bismuth content of ore exported, in kilograms.)

[e] Mining industry of Japan in 1918, Dept. Agr. and Commerce, Imp. Bur. Mines. (Reported as output of bismuth in kin and kwan; kwan × 0.00375=metric ton; kin ×0.0006=metric ton.)

[f] Data not available.

[g] Cuerpo de ingenieros de minas Bol. 95, p. 234, 1917. (Reported as bismuth content in kilograms of ore exported.)

[h] Estadística minera de España, Consejo de minería, Ministerio de Fomento. (Reported as production of ore by mines, and bismuth [metallic?] by reduction works.) No production of bismuth reported before 1918, when 12,000 kilograms was produced.

SELENIUM.

By James M. Hill.

PRODUCTION.

The production of selenium in 1919 was 60,025 pounds, valued at approximately $125,966. As compared with 103,694 pounds, valued at $206,540, produced in 1918, this was a decrease of 42 per cent in quantity and 39 per cent in value. Selenium was recovered in 1919 as a by-product in the electrolytic copper refineries operated by the Raritan Copper Works, Nichols Copper Co., and American Smelting & Refining Co.

IMPORTS.

As will be seen by the following table, the imports of selenium and selenium salts into the United States have never been large.

Value of selenium and selenium salts imported for consumption in the United States, 1914-1919.

1914	$43	1917	$2,236
1915	59	1918	.....
1916	302	1919	25,866

CONSUMPTION.

The reported sales of selenium during 1919 amounted to 18,206 pounds, most of which was used as a coloring and deoxidizing agent by the glass industry.

PRICE.

Producers reported prices varying from $1.75 to $3 a pound. Quoted prices fluctuated very little during the year, ranging from $1.50 to $2 a pound for the amorphous powder.

An interesting article on the properties and utilization of selenium has recently been published by Ancel.[1] A privately printed pamphlet by Wein[2] gives information concerning the various forms in which selenium is recovered and discusses the history and development of selenium cells.

[1] Ancel, Louis, Selenium and its present uses: Chimie et industrie, vol. 2, No. 3, p. 245, 1919.
[2] Wein, Samuel, Selenium cells, and how they are made: The Progress Press, New York, Nov. 28, 1919.

TELLURIUM.

By James M. Hill.

There was a small demand for tellurium in 1919, but as only one producer, the Raritan Copper Works, reported production or sale of this metal, it is not possible to give figures showing production. Stocks of tellurium are apparently large as compared with the annual consumption.

MAGNESIUM.

By R. W. Stone.

PRODUCTION.

Three companies in the United States made 127,465 pounds of metallic magnesium in 1919, valued at $247,302, a decrease of 55 per cent in quantity and 60 per cent in value from the output in 1918. A large decrease was to be expected from the fact that metallic magnesium was used in 1918 principally for war purposes—to give light and smoke in star shells, flares, tracer bullets, and other projectiles, and as a high explosive ingredient in trench-mortar shells. Furthermore, foreign orders filled in 1918 took more than 50,000 pounds. This demand ceased in November, 1918, and the industry suffered a serious decline, which continued through 1919. The production in 1919, however, was greater than in any year before 1918 and shows that the peace-time demands are increasing.

Most of the magnesium marketed in 1919 was in stick form, but more than one-tenth of the output was sold by the original producer in powdered form. As only one of the three producers makes powdered magnesium, the exact figures of the quantity produced as sticks and as powder can not be given without revealing confidential information. It may be stated that the decrease in production of powdered magnesium was 87 per cent, as compared with a decrease of only 24 per cent in stick magnesium.

Metallic magnesium produced in the United States, 1915–1919.

Year.	Number of producers.	Quantity (pounds).	Value.	Average price per pound.	
				Stick.	Powder.
1915	3	87,500	$440,000	$5.00	.....
1916	4	75,400	311,462	4.13	.....
1917	5	115,813	233,626	2.02	.....
1918	4	284,118	615,217	1.81	$2.67
1919	3	127,465	247,302	1.83	2.85

The figures in this table represent the quantity of metallic magnesium manufactured each year. Sales are not given, because they are almost equivalent to the production, and to record this industry by sales would involve a record of stocks on hand at the end of the year and of the quantity consumed by the producers in experimental work.

The total value given above represents the quantity manufactured, computed at the average selling price for the year as reported by each company for its product. The values given for 1918 and 1919 divided by the quantities do not give the average value, because both powder and stick magnesium were made and their values are different.

PRODUCERS.

Magnesium was produced at four plants in 1919. The American Magnesium Corporation operated plants at Niagara Falls, N. Y., and at Rumford, Maine. The company's office is at Niagara Falls. The Norton Laboratories (Inc.), Madison Avenue at Forty-first Street, New York City, made magnesium at Lockport, N. Y., and the Dow Chemical Co. at Midland, Mich.

PRICE.

The American Metal Market quoted metallic magnesium (99 per cent or more) at $1.75 to $2 a pound throughout the year. The producers state, however, that the scheduled price of metallic magnesium in sticks ranged in 1919 from $1.60 to $2, and in powder from $2.60 to $3. The average price of magnesium in sticks, according to the best information available, was about $1.83 a pound, or practically the same as in 1918. Although some large lots of magnesium were sold at $1.55 and $1.60 a pound, other lots that brought a much higher price, and certain contracts with foreign Governments that were settled in 1919 raised the average selling price for the year to $1.83.

Magnesium powder brings a higher price than magnesium in sticks, because of the additional fabrication required, and varies in price according to the quantity sold and the fineness of the material. Magnesium powder as marketed in 1919 ranged from 50-mesh to 200-mesh. The average price for the year is difficult to determine but is estimated at $2.85 a pound.

IMPORTS AND EXPORTS.

The Bureau of Foreign and Domestic Commerce of the Department of Commerce records imports and exports of "barium, calcium, magnesium, sodium, and potassium, and alloys of which said metals are the component material of chief value," in one class, which is subject to a 25 per cent duty. Magnesium ribbon was erroneously stated in this chapter for 1918 as subject to a 20 per cent duty. According to paragraph 143 of the act of October 3, 1913, the duty is 25 per centum ad valorem.

Magnesium was not separately recorded by the Bureau of Foreign and Domestic Commerce prior to July, 1918. The imports during the 6 months July to December, 1918, amounted to 11,899 pounds, valued at $16,259, and for 12 months ending December, 1919, to 13,239 pounds, valued at $13,583.

No information is obtained by the customs officials regarding the exports of magnesium alone. Although 50,000 to 60,000 pounds was sold to the allies in 1918, presumably for war uses, exports practically ceased with the end of that year, and only a small quantity, if any, was exported in 1919.

SOURCE OF METAL.

The metal magnesium is obtained from different sources, including anhydrous sodium-magnesium chloride left after the extraction of salt from brines at Midland, Mich., and Pomeroy, Ohio; magnesium chloride derived from the water of Great Salt Lake, Utah, and from sea water on San Francisco Bay, Calif.; California magnesite; and magnesium carbonate precipitated from dolomite. Some of these raw materials have been shipped long distances, as metallic magnesium has not been made west of Michigan.

CHARACTER AND USES.

The character and uses of metallic magnesium were discussed fully in the report for 1918, and that discussion will not be repeated here. Magnesium is a very light metal resembling silver in color, which comes on the market in cast bars or sticks, as a thin, narrow ribbon, and in powder. Its principal uses are as a deoxidizing agent or scavenger in brass, bronze, copper, nickel, and aluminum foundries, as an alloy with aluminum and other metals, as a flashlight powder in photography, and as an illuminant in pyrotechnics and projectiles.

More magnesium is used at present as a scavenger in metallurgy than for any other purpose, but its use as an alloy is increasing and may eventually become the major one. It is alloyed with aluminum for castings for aircraft engines and parts of airplanes. When improved methods and increased production make it possible to produce magnesium at a much lower cost than at present, magnesium alloys will probably have a much wider use, extending even to kitchen utensils.

BIBLIOGRAPHY.

The following is a partial list of articles of recent date relating to metallic magnesium:

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BAUXITE AND ALUMINUM.

By James M. Hill.

BAUXITE.

DOMESTIC PRODUCTION.

The quantity of bauxite marketed in the United States in 1919 was 376,566 long tons, which had a value at the mines of $2,201,747, a decrease from the production of 1918 of about 38 per cent in quantity and about 36 per cent in value. The production in Georgia, Alabama, and Tennessee in 1919 was 43,076 long tons, an increase of less than 1 per cent, but the production in Arkansas, was only 333,490 long tons, a decrease of about 41 per cent.

The domestic consumption of bauxite in 1919 was about 38 per cent less than that in 1918. Considerable bauxite was imported from South America. Most of the bauxite exported, which included bauxite concentrates, was apparently shipped to Canadian producers of aluminum and abrasives.

Bauxite produced and consumed in the United States, 1915–1919.

Year.	Domestic production.					
	Georgia, Alabama, and Tennessee.		Arkansas.		Total.	
	Quantity (long tons).	Value.	Quantity. (long tons).	Value.	Quantity. (long tons).	Value.
1915	28,245	$144,345	268,796	$1,370,489	297,041	$1,514,834
1916	49,190	284,810	375,910	2,011,590	425,100	2,296,400
1917	62,134	395,051	506,556	2,724,007	568,690	3,119,058
1918	42,829	314,112	562,892	3,133,880	605,721	3,447,992
1919	43,076	346,588	333,490	1,855,159	376,566	2,201,747

Year.	Imports.		Exports.[a]		Domestic consumption.	
	Quantity (long tons).	Value.	Quantity. (long tons).	Value.	Quantity. (long tons).	Value.
1915	3,420	$17,107	16,082	$717,186	284,379	$814,755
1916	30	87	17,939	987,454	407,191	1,309,033
1917	7,691	28,989	21,791	1,323,926	554,590	1,824,121
1918	3,653	14,791	19,711	1,523,688	589,663	1,939,095
1919	6,082	36,820	17,701	1,372,094	364,947	866,473

[a] Includes bauxite concentrates.

Of the domestic bauxite marketed in 1919, the producers of aluminum took about 272,270 long tons, the makers of chemicals about 67,842 tons, the makers of abrasives about 35,395 tons, and the makers of refractories about 1,059 tons.

The quantity of bauxite consumed by the aluminum industry in 1919 was 35 per cent less than in 1918, and the abrasive industry consumed nearly 70 per cent less in 1919 than in 1918. These decreases can be attributed directly to overstocks of aluminum and of artificial abrasives that were accumulated during the war.

Makers of chemicals used 3,946 tons more bauxite in 1919 than in 1918, but makers of refractory products used nearly 9,000 tons less.

The total quantity of domestic bauxite marketed is 11,619 tons greater than the apparent domestic consumption given in the table above. This discrepancy is probably due in part to stocks carried at consuming works and in part to loss in the manufacture of "refined bauxite," a product that is largely exported.

MARKET AND PRICES.

The market for bauxite in the United States is east of Mississippi River. Recently a number of municipal and industrial waterworks have installed small plants for the manufacture of aluminum sulphate for local use in purification of water. A complete list of those known to the United States Geological Survey to be users of bauxite follows:

Aluminum Co. of America, Pittsburgh, Pa.
Booth Chemical Co., P. O. Box 203. Elizabeth, N. J.
Carborundum Co., Niagara Falls, N. Y.
Charles Lennig & Co. (Inc.), 112 South Front Street, Philadelphia, Pa.
Charles Taylor Sons Co., Cincinnati, Ohio.
Columbus Waterworks, R. D. 5, Columbus, Ohio.
Cumberland Waterworks, R. D. 3, Cumberland, Md.
Detroit Chemical Works, 238 Junction Avenue, Detroit, Mich.
E. I. du Pont de Nemours Powder Co., Wilmington, Del.
Erie Chemical Works, 31 Union Square W., New York, N. Y.
Exolon Co., 156 Sixth Street, Cambridge, Mass.
General Abrasives Co., Niagara Falls, N. Y.
General Refractories Co., Trinity Building, New York, N. Y.
Harbison-Walker Refractories Co., Pittsburgh, Pa.
International Abrasive Corporation, 5 Dorchester Avenue Extended, Boston, Mass.
Jarecki Chemical Co., St. Bernard Station, Cincinnati, Ohio.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Massillon Stone & Fire Brick Co., Massillon, Ohio.
Merrimac Chemical Co., 33 Broad Street, Boston, Mass.
Metropolitan Water District of Omaha, Omaha, Nebr. (R. B. Howell, general manager.)
Montclair Waterworks, Little Falls, N. J.
Norton Co., Worcester, Mass. (also Niagara Falls, N. Y.).
Pennsylvania Salt Manufacturing Co., Widener Building, Philadelphia, Pa.
Springfield Waterworks, Springfield, Mass.
Superior Chemical Co., Joliet, Ill.

Bauxite is graded according to its chemical composition and is sold to the consuming industries according to analysis. Apparently a low content of silica and titanium is essential to the bauxite used in the aluminum industry, but the content of iron may be fairly high, though bauxites low in iron and titanium are preferred by the makers of alum and aluminum sulphate. Bauxite that is to be marketed must carry at least 52 per cent of alumina (Al_2O_3) and preferably more. Makers of abrasives appear to be able to use bauxite of lower grade containing larger proportions of silica and iron than are permissible in bauxite for other uses, but abrasives are made from bauxite low in silica and iron. The bauxite used for refractories must apparently be fairly low in iron.

The prices received for bauxite in 1919, as reported by producers, ranged from $5.45 to $12 a long ton; the average price paid for all the domestic bauxite sold in this country was $5.85 a long ton at the shipping point. It should be understood that the average price computed from the assigned value of the total production is considerably less than the price at which bauxite can be purchased in small lots, because of the fact that the larger consumers operate their own mines and assign to their output an arbitrary value, which is presumably based on operating costs.

WORLD'S PRODUCTION.

Data on the output of the French bauxite mines have been withheld since the beginning of the war.

World's production of bauxite, 1915–1918.

Country.	1915		1916		1917		1918	
	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
United States	301,794	$1,514,834	431,902	$2,296,400	577,789	$3,119,058	615,413	$3,447,992
France	(a)	(a)	[b] 23,412	(a)	[b] 38,115	(a)	(a)	(a)
United Kingdom [c]	11,911	15,393	10,494	14,477	14,960	20,106	9,742	13,270
Italy [d]	6,608	15,942	8,886	(a)	7,789	67,647	(a)	(a)
British Guiana [e]			(a)	(a)	(a)	(a)	4,266	(a)
India [e]	890	141	762	2,253	1,385	3,017	1,211	4,336
Spain [f]							460	1,598

[a] Statistics not available.
[b] Production in Cette consular district, France, only. Supplement to Commerce Repts. No. 52, U. S. Dept. Commerce, Dec. 5, 1918.
[c] Value given in official report in pounds; conversion factor $4.85=£1.
[d] Value given in official report in lire; conversion factor $0.193=1 lira.
[e] British Guiana Land and Mines Dept. Rept., 1918, p. 11, 1919.
[f] No production reported officially prior to 1918. Value given in official report in pesetas; conversion factor $0.1930=1 peseta.

BAUXITE IN THE UNITED STATES.

The bauxite deposits of the United States are in central Arkansas, northeastern Alabama, northwestern Georgia, southern-central Tennessee, central and central-western Georgia, and northeastern Tennessee.

The bauxite from all localities in the United States, though it may vary in chemical composition, is on the whole similar in general appearance, with the exception of the "granitic bauxite" of the Arkansas field. The greater part of the American bauxite appears to be made up of rounded pebble-like bodies set in a fine-grained matrix, which may also consist of small rounded particles or may be as fine grained as the finest clay. The pebble or pisolite form is so general that it is the conspicuous characteristic of American bauxite.

The value of bauxite can be determined only by chemical analysis, which should show total silica, alumina, titanium oxide, iron oxide, and water.

The report on bauxite and aluminum for the year 1918 contained a bibliography of the literature on domestic bauxite deposits and a map showing the location of bauxite-producing areas and consuming plants.

Alabama.—So far as can be learned the Republic Mining & Manufacturing Co., near Rock Run, Cherokee County, and the Consolidated Mining Co., near Fort Payne, Dekalb County, were the only operators in Alabama during 1919. The deposits near Talladega were not exploited.

Arkansas.—The American Bauxite Co., the Globe Bauxite Co., E. I. du Pont de Nemours & Co., and the Republic Mining & Manufacturing Co. mined bauxite from deposits in Saline and Pulaski counties, Ark. The largest production was obtained from the deposits near Bauxite, Saline County.

All the bauxite used in the United States in the manufacture of aluminum in 1919 (272,270 long tons) came from Arkansas deposits. These deposits also furnished 28,981 long tons to the chemical industries, 31,180 long tons to the abrasive industries, and 1,059 long tons to the makers of refractories.

Georgia.—In 1919 Georgia deposits yielded 37,201 long tons of bauxite, which is an increase of 1,564 tons over the production in 1918. The producing counties, named in order of output, are Wilkinson, Sumter, Floyd, Bartow, Randolph, Macon, and Meriwether. Most of the bauxite produced in Georgia was consumed by the chemical industries, a relatively small part entering the abrasive industries.

In Wilkinson County the Republic Mining & Manufacturing Co. and the General Bauxite Corporation are operating mines near Toomsboro. The deposits formerly worked by the Du Pont interests have been mined out. The Republic Mining & Manufacturing Co. was practically the only operator in Sumter County. It is reported that the overburden of the deposits at Sweetwater is becoming so thick as to greatly hinder the extraction of bauxite. The deposits lying north and west of Andersonville were apparently not operated in 1919. The Republic Mining & Manufacturing Co. is also taking bauxite from deposits in Bartow, Floyd, and Meriwether counties. The Warner Mining Co. is still operating its deposits near Adairsville, Floyd County. Asbury & Sparks, who formerly operated mines in Floyd County and in Alabama, did not mine bauxite in 1919. In Macon County bauxite is produced by the Mineral Products Co. and the Ideal Bauxite Co.

Tennessee.—A little bauxite produced near East Chattanooga, Tenn., was sold in 1919, and the mines of the Watauga Mining Co., near Elizabethton, Carter County, were operated.

BAUXITE IN FOREIGN COUNTRIES.

EUROPE.

In the report on bauxite for 1918 a brief review of foreign deposits of bauxite was given. There is practically no available information concerning developments in France, Germany, or Italy. Deposits in Barcelona Province, Spain, were opened in 1918 and made an initial production of 460 metric tons, valued at 8,280 pesetas. Bauxite deposits in Cataluña have also been described[1] but apparently are not productive.

[1] Gatatayud, J. E. N., Las bauxitas de Cataluña: Real Acad. de ciencias exactas Revista, vol. 17, 2d ser., pp. 422-470, Madrid, 1919.

The Irish deposits are still under operation and in 1918 produced 9,589 long tons of bauxite, valued at £2,736.[2] It is reported that bauxite which may be used for the manufacture of refractories has been found in Ayrshire, Scotland.[3]

INDIA.

Fermor[4] believes that there are large reserves of good-grade bauxite in the Central Provinces of India. The analyses he published indicate a high-alumina bauxite but show also a high content of titanium. The principal deposits are on the Baihir plateau, in the Balaghat district, and near Katni, in the Jubbulpore district. Bauxite has also been found in the Sarguja district, Jashur State, and in the Mandla and Seoni districts of the Central Provinces. Fermor gives the following table:

Bauxite produced in India, 1909–1918, in long tons.

1909–1913 (average)	449
1914	514
1915	876
1916	750
1917	1,363
1918	1,192

The value of the output in 1918 was £894.

AFRICA.

Bauxite deposits of fair grade are known at Mount Ejuanema, near Mpraeso, Gold Coast, and at Dalawe, in Togoland, Africa.[5]

BRITISH GUIANA.

The Demerara Bauxite Co., operating the Three Friends deposits, above Georgetown, on Demerara River, British Guiana, shipped 4,199 long tons of bauxite in 1918 and paid the Government a royalty of 10 cents a ton on all bauxite taken from Crown lands.[6] The total quantity of bauxite shipped from these deposits up to the end of 1918 is stated to be 6,236 long tons.

From all available information the British Guiana deposits are very extensive and of exceptionally high grade. Some of the available deposits are under private control; others are on Government-owned lands. There is no recent news concerning the attitude of the Government with respect to the disposition of bauxite deposits on Crown land, but apparently British companies will be given preference, as in the past.

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[2] Mines and Quarries General Rept. (Home Office), 1919, p. 7.
[3] Min. Jour. (London), Feb. 7, 1920.
[4] Fermor, L. L., The mineral resources of the Central Provinces: India Geol. Survey Rec., vol. 50, pt. 4, pp. 268–273, 1919.
[5] Kitsen, A. E., Gold Coast, Report of the Geological Survey for the year 1918: Min. Mag., July, 1919, pp. 49–50.
[6] British Guiana Lands and Mines Dept. Rept., 1918, p. 11, 1919.

ALUMINUM.

DOMESTIC PRODUCTION AND CONSUMPTION.

The value of primary aluminum produced in the United States in 1919 was $38,558,000, a decrease of about 6 per cent from the value of the output in 1918. The decrease was due largely to curtailment in the production of aluminum forced by the accumulation of large stocks in the preceding year.

Value of aluminum produced and consumed in the United States, 1915–1919.

Year.	Domestic production.		Imports.[b]	Exports.[c]	Apparent consumption.
	Primary metal.	Secondary metal.[a]			
1915	$16,280,000	$5,802,100	$1,841,779	$3,682,117	$20,241,762
1916	33,900,000	23,430,200	1,785,870	15,417,134	43,698,936
1917	45,882,000	16,711,800	56,890	14,586,467	48,064,223
1918	41,159,000	10,113,600	554,586	10,869,388	40,957,798
1919	38,558,000	12,014,000	4,568,595	3,890,326	51,250,869

[a] Value based on average open-market price, as quoted by Engineering and Mining Journal.
[b] Imports for consumption, figures from Department of Commerce reports. Includes aluminum in crude form, leaf, sheets, plates, bars, strips, wire, rods, and all manufactures of; table, kitchen, and hospital ware.
[c] Exports of aluminum and manufactures of; figures from Department of Commerce reports.

MARKET AND PRICES.

The demand for aluminum during the war was large, owing to the extensive use of aluminum in the automotive industry. Aluminum was released in 1919 for some uses that had been poorly supplied during 1917 and 1918, as they were not essential to war activities. On the whole the supply seems to have been adequate, as large stocks were on hand at the beginning of the year. During the latter part of the year the supply of metal was not quite so free, though there was little delay in receiving orders.

Open-market quotations on aluminum have been nearly stationary, around 33 cents a pound, since May, 1919. During the first four months of the year there was a declining market and the price reached its lowest point, 30 cents a pound, in April. By that time a large part of the accumulated stocks had been absorbed, and the prices for the later months represent more nearly the trend of the market.

Open-market prices of aluminum, 1915–1919, in cents per pound.

Month.	1915	1916	1917	1918	1919
January	19.08	55.00	59.20	37.10	32.33
February	19.22	58.00	58.30	37.00	31.25
March	19.00	60.25	59.20	32.00	31.00
April	18.88	59.50	60.00	32.00	30.00
May	22.03	59.00	60.00	32.00	33.00
June	30.00	61.50	60.00	33.00	33.00
July	32.38	60.20	56.10	33.00	33.00
August	34.50	60.00	49.00	33.00	33.00
September	47.75	61.88	43.20	33.00	33.00
October	50.00	65.05	39.30	33.00	33.00
November	57.75	65.12	36.70	33.00	33.00
December	57.13	63.00	37.00	33.00	33.00

NOTES ON THE ALUMINUM INDUSTRY.

It is reported that the plant capacity for the production of both aluminum metal and fabricated articles has been expanded. New plate mills are being built by the Aluminum Co. of America at

Alcoa, near Maryville, Tenn., and the mills at New Kensington, Pa., are being enlarged to supply the increased automobile demands. The increasing use of aluminum foil to replace the more expensive tin foil has necessitated an expansion of producing capacity, and it has been found necessary to enlarge plants for making aluminum powder used in paints.

The position of the aluminum works built in Germany during the war is still uncertain. It seems possible that they may be able to compete in the German markets for a short time, until the plants in France, Great Britain, and America return to more normal conditions of production. At present these countries can hardly supply the home demand, and it seems that this condition must continue at least during 1920 and possibly longer.

It is reported that more or less successful attempts have been made by the Norsk Electrochemick Co. of Norway to extract alumina from labradorite by treatment with nitric acid. The work is progressing, and it is stated that a plant for handling labradorite on a commercial scale is being built. The works of the Hoyang-Faldene Co. are to be pushed to completion, and the electrode, carbide, and iron producing equipment has been in operation.

The war delayed completion of the alumina works in France in which the Société des alumines et bauxites de Provence is interested, but these works are now to be built.

Nothing further has been learned of the report that Tata & Sons were to erect aluminum works in India, though they are making extensive exploration for raw materials.

ALUMINUM SALTS.

The principal aluminum salts made in the United States are alumina, alums (mainly ammonium and sodium alums), aluminum sulphate, and aluminum chloride. Alumina is largely consumed in the manufacture of aluminum, and no figures to show the domestic production are available for publication.

Alums of various qualities are produced at 8 plants in the eastern United States, and the total production of alum in 1919 was 17,019 short tons, valued at $879,198, a decrease of approximately 16 per cent in quantity and value from the production in 1918. The average price reported by makers of alums was $51.66 a short ton.

Aluminum sulphate is made at 23 plants, 5 of which are at municipal or industrial waterworks, which consume their entire output. The total quantity of aluminum sulphate produced in the United States in 1919 was 200,034 short tons, of which 4,725 short tons did not enter the market but was used for purifying water at the place of manufacture. The quantity of domestic aluminum sulphate that entered the market in 1919—195,309 short tons—was less than the quantity in 1918 by about 3 per cent, and the total domestic production decreased about 1 per cent. The price reported by makers of aluminum sulphate for the output in 1919 averaged $33.80 a short ton.

Aluminum chloride was produced at three plants in 1919, and the total output reported to the Geological Survey was 4,806 short tons, valued at $371,850. This is an increase of 14 per cent in quantity and 10 per cent in value over the output in 1918.

Alum and aluminum sulphate produced in the United States and aluminum salts imported, 1915–1919.

Year.	Production.						Imports.[a]	
	Alum.			Aluminum sulphate.			Quantity (short tons).	Value.
	Quantity (short tons).	Value.	Price per ton.	Quantity (short tons).	Value.	Price per ton.		
1915	24,915	$699,256	$28.07	169,153	$3,224,495	$19.06	1,408	$34,320
1916	27,257	1,177,881	43.21	153,860	4,410,741	28.67	1,247	68,660
1917	19,714	1,017,083	51.60	178,738	5,746,427	32.15	507	39,088
1918	20,286	1,051,449	51.83	209,079	6,473,086	30.96	231	18,519
1919	17,019	879,198	51.66	200,034	6,763,063	33.80	343	21,877

[a] Includes alumina, aluminum hydrate or refined bauxite, alum, alum cake, aluminum sulphate, aluminous cake, and alum in crystals or ground.

OTHER BAUXITE PRODUCTS.

BAUXITE ABRASIVES.

Bauxite abrasives sold under various trade names, such as alundum, aloxite, exolon, and lionite, are made by fusing bauxite in an electric furnace. These products are sold in the form of powders, cloth, grinding stones, and wheels of various shapes, and for a multitude of uses. It is not possible to give figures showing the output of bauxite abrasives in 1919, owing to the objection of one of the large producers. In 1917 the abrasives sold amounted to 48,460 short tons, and in making them 109,580 long tons of bauxite was consumed. In 1918 the abrasive industry used 112,908 long tons of bauxite and in 1919 only 35,395 long tons. It is evident that the output of abrasives must have diminished considerably.

HIGH-ALUMINA REFRACTORIES.

Two classes of high-alumina refractories are now on the market. What are commonly called bauxite brick are made by mixing various proportions of calcined bauxite or high-alumina clay with a bonding material such as fire clay, sodium silicate, or lime. Refractories of this character are being made by the Laclede Christy Clay Products Co., the Harbison-Walker Refractories Co., Charles Taylor & Sons, and the Massillon Stone & Fire Brick Co. Not all the refractories made by these companies are sold as bauxite brick, and, in fact, some do not contain bauxite. The other class of high-alumina refractories consists of those made by the electric fusing of bauxite. These are manufactured by the companies that make artificial abrasives. Some of the high-silica alumina saved as a by-product in the reduction of Utah alunite is now being sold to makers of refractories, and some is being used in the preparation of potassium-aluminum sulphate.

No figures are available to show the production of high-alumina refractories, though it is known that at least 2,313 long tons of bauxite was consumed in making refractories in 1917, 9,874 long tons in 1918, and 1,059 long tons in 1919.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE EASTERN STATES.

(MINES REPORT.)

By J. P. Dunlop.

MINE PRODUCTION.

The total value of the gold, silver, copper, lead, and zinc mined and sold in the Eastern States in 1919, was $26,110,186, a decrease of about 5 per cent from the corresponding value in 1918. Of this total gold represented $7,052, silver $117,253, copper $3,086,890, lead $232,034, and zinc $22,666,957.

As will be seen from the following table, the output of all metals decreased, though the decreases in quantity of copper, lead, and zinc were comparatively small. The decrease in total value of the metals was caused mainly by the lower price in 1919 for copper, lead, and zinc. The high price of silver caused its value to increase, notwithstanding a decrease in quantity.

Mine production of gold, silver, copper, lead, and zinc in the Appalachian States, 1918 and 1919.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	2,355,688	$14,352	106,585	17,858,535	5,158,329	248,563,192	$27,517,488
1919	1,930,411	7,052	104,690	16,596,182	4,378,000	242,558,000	26,110,186
Decrease	425,277	7,300	1,895	1,262,353	780,329	6,005,192	1,407,302

GOLD.

The mine production of gold in the Eastern States in 1919 was only 341.14 fine ounces, having a total value of $7,052, as compared with 694.27 fine ounces, valued at $14,352, in 1918. Of this output the placers yielded 34.59 ounces, the siliceous gold ores 5.32 ounces, and the copper ores 301.23 ounces. Only a few tons of siliceous ore was treated, and none of the larger milling plants were in steady operation. Most of the ore is of low grade and apparently can not be mined profitably under conditions that have prevailed during the last three years. Scarcity of labor and high wages in other industries practically suspended all output of gold from placer mining. The small output that is usually purchased by banks and merchants from the spasmodic working of small scattered diggings was much less than it had been for 20 years.

SILVER.

In 1919 the mine production of silver in the Eastern States was 104,690 fine ounces, valued at $117,253, a decrease of 1,895 ounces but an increase of $10,668 in value compared with the production in 1918. The largest part of the output was derived from copper ores, 104,680 ounces, and the smallest from siliceous gold ores, 2 ounces, as is shown by the second table below. No silver was recovered from lead or lead-zinc ores, and the silver contained in bullion from placer mines was only 8 ounces.

Mine production of gold and silver in the Eastern States in 1919, by States.

State.	Gold.		Silver.		Increase or decrease in value compared with 1918.	
	Quantity.	Value.	Quantity.	Value.	Gold.	Silver.
	Fine ounces.		*Fine ounces.*			
Alabama and Georgia	37.10	$767	8	$9	−$5,923	−$18
Maine, New Hampshire, New York, and Vermont	25.25	522	6,356	7,119	−243	−3,988
North Carolina and South Carolina	4.89	101	38	42	−1,530	+25
Tennessee	273.90	5,662	98,288	110,083	+796	+16,463
Virginia	.....	.....	.....	.....	−400	−1,814
Total, 1919	341.14	7,052	104,690	117,253	.....	.....
Total, 1918	694.27	14,352	106,585	106,585	.....	.....
Increase or decrease, 1919	−353.13	−7,300	−1,895	+10,668	.....	.....

Mine production of gold and silver in the Eastern States in 1919, by sources, in fine ounces.

State.	Gold.			Silver.		
	Placers.	Dry or siliceous ores.	Copper ores.	Placers.	Dry or siliceous ores.	Copper ores.
Georgia	34.59	2.51	.....	8	.....	.....
Maine	.....	.....	7.01	.....	.....	4,142
North Carolina and South Carolina	.....	2.81	2.08	.....	2	36
Tennessee	.....	.....	273.90	.....	.....	98,288
Vermont	.....	.....	18.24	.....	.....	2,214
Total, 1919	34.59	5.32	301.23	8	2	104,680
Total, 1918	318.84	83.68	291.75	29	15	106,541

COPPER.

The mine production of copper in the Eastern States in 1919 was 16,596,182 pounds, valued at $3,086,890, a decrease in quantity from 1918 of 1,262,353 pounds and in value of $1,324,168. This copper was largely derived from Tennessee copper ores, but some came from ores mined in Georgia, Maine, North Carolina, South Carolina, and Vermont. The total quantity of ore and tailings treated to produce this copper was 590,801 tons, showing an average yield of copper of approximately 1.4 per cent, or 28 pounds to the ton.

Crude copper ores directly smelted amounted to 555,401 tons, from which 15,637,528 pounds of copper was recovered. Copper

ores concentrated amounted to 35,400 tons, which yielded 1,540 tons of concentrates containing 958,654 pounds of copper.

LEAD.

The mine production of lead in the Eastern States in 1919 was 4,378,000 pounds, valued at $232,034, a decrease of 15 per cent in quantity and of about 37 per cent in value. Tennessee mines produced 4,376,000 pounds, and there was also a very small production from Maine.

ZINC.

The production of zinc in the Eastern States in 1919 was 242,558,000 pounds, valued at $22,666,957, a decrease in quantity of 6,005,192 pounds but an increase in value of $47,707 from the production in 1918.

New Jersey, with an output of 185,824,000 pounds, produced more zinc than all the remaining Eastern States; Tennessee was second, with an output of 46,494,000 pounds, and New York was third in rank, with approximately 10,240,000 pounds.

REVIEW BY STATES.

ALABAMA.

The value of the gold produced in Alabama during the period 1830 to 1918 was $766,336.[1] In 1918 the production amounted to $797. None of the mines reported any yield of gold in 1919, and apparently no development work was done at the Gold Log, Gold Ridge, and other former producing properties in Cherokee, Randolph, and Tallapoosa counties.

GEORGIA.

The value of the gold produced in Georgia during the period 1830 to 1918 was $17,823,769,[2] or more than one-third of the estimated total production of the southern Appalachian States.

In 1919 mines in Georgia produced 37.10 ounces of gold, valued at $767, 8 ounces of silver, and 8,306 pounds of copper, a decrease of $5,126 in the value of gold and of 17 ounces in the quantity of silver from the production in 1918. The copper produced in 1919 was obtained from ore mined in the Number Twenty mine, in the Ducktown district, which lies partly in Fannin County, Ga., the ore being shipped to Tennessee for smelting.

Of the output of the metals named in 1919 placer mines furnished 34.59 ounces of gold and 8 ounces of silver and deep mines the remainder. The only deep gold mine in operation in the State treated experimentally 3 short tons of siliceous ore, from which 2.51 ounces of gold was recovered.

Two or three small placer mines were operated in Haralson and Lumpkin counties. The only placer mine operated in Haralson County was that of the Georgia Gold Mining Co., which sluiced a small quantity of gravel containing about $1.25 in gold to the cubic yard.

Some development work was done at the Barton placer by F. L. Stone, of Dahlonega, and a small experimental run of gravel yielded a few ounces of gold. Scarcity of labor has retarded the effort to

[1] Director of the Mint Ann. Rept., 1919, p. 51. [2] Idem, p. 51.

change the channel of the creek. Some development work was done also at the Findley mine of the Water Power & Development Co., and a few tons of ore was treated. At the Whim Hill mine, near Auraria, the shaft and old workings were cleared out, exposing some good ore, but work was suspended at the end of 1919 until new equipment could be installed. Considerable work was done in the attempt to reopen the Bola Fields pocket mine, but no gold was recovered. No ore was milled at the Columbia mine, near Thomson, in McDuffie County, though some work was done at the property in 1919.

MAINE.

In 1919 the American Smelting & Refining Co. shipped copper concentrates recovered in 1918 from the old Douglas mine, at Blue Hill, Hancock County, Me. The siliceous chalcopyrite ore was treated by flotation and yielded considerable copper and small quantities of gold and silver. The mine, which is opened by a 300-foot inclined shaft and equipped with a 125-ton concentrating plant, was closed early in 1919.

MARYLAND.

Apparently no mines of these metals were operated in Maryland in 1919. The total value of the gold produced in Maryland for the period 1867 to 1919 was $71,405.[3]

MASSACHUSETTS.

By G. F. Loughlin.

The old Chipman mine, at Highfield, about 3 miles south of Newburyport, Mass., was reopened in 1919 by the Merrimac Development Co. This deposit was discovered in 1874 and worked until 1879, when it was closed because of the decrease in size and metal content of the vein. Its total production during that period was about 1,500 tons of concentrates, which averaged $100 a ton.[4] Two shafts, the Chipman and the Boynton, were sunk on adjoining claims, the Chipman to a depth of 220 feet, and drifts, with a few short crosscuts, were run at the 40, 60, 100, 150, and 220 foot levels. Work by the present operators has advanced little beyond the clearing out of these old workings, although a small quantity of ore has been shipped in 1920. Development has been greatly retarded by an unusually severe winter and the general difficulty in procuring supplies.

The local rock formations, according to Clapp and Ball,[5] include a group of hornblendic schists and metamorphic limestones of northeastward strike and steep northwestward dip, which form large lenticular masses inclosed in gneissic diorite. All these rocks are cut by numerous intrusions of gneissic granite, which range in size from mere stringers to irregular masses 200 feet wide. The granite and older rocks are cut by the mineral veins, and both rocks and veins are cut by diabasic dikes.

The ore body is a replacement vein, with well-defined walls, characterized by pinches and swells, and cutting a complex of schist, limestone, and igneous rock. Its strike is N. 80° E. and its dip is steep

[3] Director of the Mint Ann. Rept., 1919., p. 52

[4] Clapp, C. H., and Ball, W. G., The lead-silver deposits at Newburyport, Mass., and their accompanying contact zones: Econ. Geology, vol. 4, p. 239, 1909.

[5] Idem, pp. 241–245.

to the south. The ore minerals seen by the writer (June, 1920) are galena and pyrite, with minor and varying quantities of tetrahedrite, chalcopyrite, and sphalerite. Considerable bornite was found on the 60-foot level. The gangue is chiefly quartz with fine to coarse grained siderite and chlorite irregularly distributed. Other minor minerals mentioned by Clapp and Ball [6] are arsenopyrite, ankerite, calcite, serpentine, agalmatolite, sericite, limonite, and kaolin. The pay shoots are lenses, most of which lie along one of the walls.

So far as can be judged from the present workings the best ore shoots were found at forks in the vein or on one side of tight cross fissures on the three upper levels. The prevailing rock noted there is crystalline limestone. Ore mined early in 1920 by the present operators was found on the two upper levels while reopening and exploring small stopes made by the old company. Samples of this ore averaged 0.25 ounce of gold and 30 ounces of silver to the ton, 40 per cent of lead, 0.75 per cent of copper, 22 per cent of silica, 15 per cent of iron, 5 per cent of lime, 15 per cent of sulphur, and less than 1 per cent of zinc and arsenic. The largest stope is on the 100-foot level, which extends from the Chipman shaft to and beyond the Boynton shaft, a distance of 120 feet. The vein here pinches and swells. The maximum thickness of ore mined in the old days was 6 feet,[7] although the entire thickness of the vein was somewhat greater. As a rule the lenses of ore are from 1 to 4 feet in maximum thickness. The low-grade and barren portions bordering the stopes consist mainly of quartz with considerable chlorite. On the 150-foot and 220-foot levels the pinch and swell is maintained. The vein so far as exposed on these levels is in siliceous rocks and consists of barren stretches with streaks or lenses of ore from a few inches to 2 feet thick.

The company's report dated August 5, 1920, states that a new ore body has been opened in the hanging wall on the 100-foot level at the Boynton shaft, and that ore has also been exposed in the hanging wall on the 220-foot level during the cutting of a new station.

Several outcrops of other veins were discovered and prospected when the Chipman mine was formerly worked. The present company has examined some of these outcrops and states that one of them merits further attention.

NEW HAMPSHIRE.

There was no output of ore from the Silver Lake mines, in Carroll County, N. H., in 1919, and operations were entirely suspended by the New Jersey Zinc Co.

NEW JERSEY.

The production of zinc ore in New Jersey in 1919 was, as usual, confined to the output of the Mine Hill and Sterling mines at Franklin Furnace, Sussex County. The crude ore produced at those mines in 1919 amounted to 615,680 tons, which yielded a total of 185,824,000 pounds of zinc. It should be understood that only part of the zinc ore mined at Franklin Furnace is used directly for the manufacture of zinc. The greater part of this zinc is normally converted into oxide at works in Pennsylvania.

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[6] Idem, p. 244.

[7] Idem, p. 240.

NEW YORK.

The Northern Ore Co., operating the Brown mine, near Edwards, St. Lawrence County, N. Y., treated 51,411 tons of zinc-bearing ore, which yielded about 10,240,000 pounds of recoverable zinc.

The 400-foot inclined shaft has been abandoned, and only a vertical shaft 900 feet deep and an 800-foot inclined shaft are now operated. Considerable prospecting was done with a diamond-core drill on the large tract of land owned by the company, and the drill was also used in the workings to locate ore and reduce the amount of drifts run.

Ore now being extracted from levels at 840 to 860 feet is dropped to the 900-foot level, hoisted, and trammed by means of a gasoline motor to the mill. The mill, which is constructed of steel and tile, is equipped with crusher, rolls, Dorr thickener, and 17 tables. The ore had been treated by flotation prior to 1919, but that process is not now in use. No jigs are used and the concentrates recovered are exclusively a table product, though experiments that are being made by Mr. Wade, the superintendent, will probably result in an increased quantity of ore being treated and in the installation of jigs to treat middlings. The table concentrates, which assay about 32 to 33 per cent of zinc, are treated by 13 Electric Ore Separating Co. machines, which, by removing much of the pyrite, raise the zinc content to 49 to 53 per cent. These electric machines treat wet concentrates, and to avoid the clogging of the riffles in the separator and insure their proper operation it is necessary to remove by means of a powerful magnet all the small particles of metallic iron abraded from the rolls and crusher.

The average zinc assay of the crude ore treated ranges from 15 to 20 per cent, and the finished concentrates, which are practically free from lead, usually average about 49 per cent. The pyrite concentrates, which contain about 43 per cent of sulphur, are in good demand when cars are available for their shipment.

The developed bodies of ore are large, and it is probable that others will be found on the large tract owned by the Northern Ore Co.

The Hyatt Ore Corporation has opened a new mine at Hyatt, 3 miles west of Edwards, and sunk a 200-foot shaft on ore very similar to that of the Northern Ore Co. The 200-ton plant under construction contains crusher, rolls, and tables and will probably be operated in October, 1920.

No shipments of silver-bearing lead ore were made by the Summitville Ore Concentrating Co. from its property in Sullivan County.

NORTH CAROLINA.

No gold was produced from quartz or placer mines in North Carolina in 1919, and at only one deep mine, that of the Rich Cog Mining Co., at Eldorado, Montgomery County, was any development work done. The value of the gold produced in North Carolina during the period 1799 to 1918 was $23,628,413.[8] In 1915 the recovery of gold amounted to $172,001, but in 1918 it decreased to $1,631, which with 17 ounces of silver was derived from placer mines or old mill clean-ups. Increased costs of mining and milling the low-grade gold ores and gravels have made operations unprofitable. The small

[8] Director of the Mint Ann. Rept., 1919, p. 52.

production in 1919 was derived from the old slag dump of the Cullowhee copper mine, from which lessees shipped about 17 tons of matte that yielded 3,334 pounds of copper, $20 in gold, and 19 ounces of silver.

PENNSYLVANIA.

The Cornwall iron mines, in Lebanon County, Pa., operated by the Bethlehem Steel Co., which produces a low-grade copper concentrate from pyritiferous magnetite ore, made no copper production from that source in 1919. The only development work done in 1919 was at an old lead mine near Phœnixville, in Chester County. The property was reopened by the Eastern Mining & Melting Co., and a 100-ton concentrating plant was under construction.

SOUTH CAROLINA.

None of the deep or placer gold mines in South Carolina were in active operation in 1919, but a small quantity of copper ore mined in 1918 was shipped from Smyrna, in York County. This ore yielded 2,299 pounds of copper and some gold and silver. A few ounces of gold and silver was derived from old battery plates. The total production of gold in 1919 was $81 and that of silver 19 ounces, valued at $21. Mines in South Carolina yielded gold valued at $5,181,429[9] during the period 1829 to 1919, or about one-fifth of the estimated total production from the Appalachian States.

TENNESSEE.

The value of the gold produced at mines in Tennessee during the period 1831 to 1918 was $253,010.[10] A large part of the output prior to 1879 was derived from placer mines, but the output since 1906 has been recovered entirely from copper ore mined in Polk County.

The annual production of silver has ranged from 56,000 ounces to more than 100,000 ounces since 1905, and that of copper from 14,500,000 pounds to 19,459,000 pounds. No production of lead was reported prior to 1915, but since that time the mines in Tennessee have yielded 12,880,000 pounds. The output of zinc, which was only 218,643 pounds in 1907, amounted to 57,000,000 pounds in 1917, and the total production from 1907 to 1919 has been 274,071,000 pounds.

Mine production of gold, silver, copper, lead, and zinc in Tennessee, 1905–1919.

Year.	Ore sold or treated.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1905	399,330	$4,362	95,522	14,541,425	.....	.....	$2,330,606
1906	538,141	4,838	55,931	17,979,317	.....	.....	3,512,320
1907	561,805	3,825	58,358	18,893,115	.....	218,643	3,833,864
1908	638,033	3,699	57,696	19,459,501	.....	688,149	2,635,275
1909	611,014	4,118	57,637	19,206,806	.....	1,192,161	2,595,350
1910	578,434	3,113	81,239	16,837,727	.....	1,932,555	2,289,731
1911	604,538	11,621	106,660	18,850,276	.....	2,234,000	2,551,774
1912	635,576	8,265	89,893	18,483,173	.....	4,381,300	3,415,583
1913	823,645	7,595	108,105	19,390,750	.....	11,166,000	3,703,752
1914	1,011,058	6,194	97,402	18,737,656	.....	20,850,000	3,615,516
1915	1,149,364	6,862	100,543	18,046,010	1,660	32,922,902	7,298,406
1916	1,184,821	5,739	94,701	14,679,794	32,960	52,855,480	10,764,189
1917	1,533,983	5,326	99,053	16,033,749	5,061,937	56,995,107	10,712,985
1918	1,159,971	4,866	93,620	14,799,680	3,410,400	42,141,311	7,831,005
1919	1,227,534	5,662	98,288	15,623,589	4,376,000	46,494,000	6,647,723
	12,657,247	86,085	1,294,648	261,562,568	12,882,957	274,071,608	73,738,079
Increase or decrease, 1919....	+67,563	+796	+4,668	+823,909	+965,600	+4,352,689	−1,183,282

[9] Director of the Mint Ann. Rept., 1919, p. 52.

[10] Idem, p. 52.

Polk County.—The entire output of copper, gold, and silver in Tennessee came from the two large copper mines in the Ducktown district, and the production of all three metals was larger in 1919 than in 1918. The Tennessee Copper Co. operated its 2,000-ton smelter, converter, and sulphuric acid plant on crude sulphide ores from the Burra Burra, London, and Polk County mines. It also smelted a small quantity of ore from the Number Twenty mine, in Fannin County, Ga. The annual report of the Tennessee Copper Co. for the calendar year 1919 says:

Burra Burra mine.—During the year McPherson shaft was sunk 463 feet, reaching a point just above the fourteenth level, from which point work will be continued for a connection with the Burra shaft and the London shaft. The tenth level of Burra mine was advanced 345.5 feet north and stoping operations begun in the ore.

A new system of ore chutes was started in the belief that it will eventually eliminate a greater part of the hand loading, for it is becoming increasingly difficult to get men to do this work.

During the latter part of the year development work was crowded to the utmost in order to get more ore available for mining.

London mine.—No development work of note took place at this mine during the year, the seventh level being continued north as a sill-floor stope, but toward the end of the year work was started on a winze to be sunk in the ore to a point to make connection with the drift from McPherson shaft, the object of this being development of the lower levels and ultimately more economical operations for London mine.

Polk County mine.—This mine was operated on a very small tonnage for converter flux during the year and no development was undertaken, as conditions did not warrant it.

Eureka mine.—No work was done at this property during the year.

Operations.—The following is a summary of the results of operations at the various mines during the year:

Summary of operations of the Tennessee Copper Co.'s mines, 1919.

	Burra Burra.	London.	Polk County.	All mines.
Development:				
Raises and winzes.....feet..	1,011	446.5	25	1,482.5
Crosscuts.....do....	141	.....	.....	141
Drifts.....do....	2,448	198	34	2,680
Shafts (Mc. Ph. 463; B. B. 8).....do....	471	.....	.....	471
Total.....	4,071	644.5	59	4,774.5
Diamond drilling:				
Total holes.....	18	.....	2	20
Feet drilled.....	2,544	.....	164	2,708
Cost per foot.....	$3.20	.....	$5.5405	$3.3355
Ore production and costs:				
Tonnage.....	266,128	81,126	31,136	378,390
Mining per ton.....	$1.3809	$1.7845	$2.1000	$1.5275
Development per ton.....	.3998	.1297	.0756	.3143
Total cost per ton.....	1.7807	1.9142	2.1756	1.8418
Estimated ore reserves:				
Available tonnage.....	3,273,645	171,987	66,924	[a] 3,512,556
Broken ore in stopes, tons (included in above).....	100,000	14,000	16,000	[a] 130,000

[a] Eureka mine not included.

The present policy is to do all development possible in both Burra Burra and London mines for the purpose of increasing the output. Ore reserves were a little better than maintained during the year.

Smelting.—The outstanding feature of smelting operations for the year was the abandonment of the use of Austral quartz and substituting therefor a better grade of quartz secured from various other places, and the better quartz, together with a higher column in the furnaces, resulted in handling the tonnage with two furnaces and making good gas for the acid plants together with a reduction in smelting costs.

An installation for granulating slag was put in during the year and is operating satisfactorily, resulting in considerably decreased cost of slag disposal.

A new quartz quarry is being opened which is expected to give an ample supply of quartz of better quality than heretofore available. * * *.

Copper production.—There were smelted during the year 413,877 tons of Tennessee Copper Co. ore which yielded 10,407,228 pounds of fine copper, or an extraction of 25.146 pounds of fine copper per ton of ore smelted. In addition to the above, 5,865 pounds of fine copper were recovered from flue dust by a clean-up from the leaching plant and 1,722 pounds from scrap, making a total production of 10,414,815 pounds of fine copper.

The total cost per ton of Tennessee Copper Co. ore was $4.753, equal to 18.715 cents per pound of fine copper produced, subdivided as follows:

Operating cost per pound of copper from Tennessee Copper Co. ores, 1919.

	Cost per pound of copper.
Mining expense	$0.07136
Railway expense	.00611
Smelting expense	.08768
Converter expense	.00830
General expense	.01370
Total operating cost per pound of fine copper from Tennessee ores (exclusive of New York charges)	.18715

The Ducktown Sulphur Copper & Iron Co. operated its two 500-ton blast furnaces on self-fluxing sulphide ore from the Mary mine, at Hyatt, and the East Tennessee and Isabella mines, at Isabella. The Mary and Isabella mines are opened by 1,200-foot vertical shafts, and the East Tennessee mine by a 700-foot shaft.

Most of the lead and zinc produced was obtained from the Embree mine, in Washington County, and the Mascot and Roseberry mines, in Jefferson County, as the mines of the Union Zinc Co. in Union County, the Tennessee Zinc Co. in Claiborne County, and the Grasselli Zinc Co. in Jefferson County were idle in 1919.

The Embree Iron Co. operated the Embree mine, which yields zinc carbonate and lead carbonate ores. Part of the zinc ore is shipped directly from the mines, and part is concentrated by means of log washers and tables. The dried crude ore contained an average of 39.95 per cent of zinc, and the concentrates contained 41.31 per cent of zinc. Some galena ore was shipped without treatment, but most of the crude ore was concentrated by means of jigs and tables into a product averaging about 62 per cent of lead.

The American Zinc Co. of Tennessee continued its steady operation of the Mascot and Roseberry mines, near Mascot, in Jefferson County, and the increased output of zinc in Tennessee was due entirely to these mines. The sulphide ore is hoisted from the Mascot mine through two shafts, one 300 feet deep and the other 700 feet deep. The concentrating plant is equipped for concentration by means of jigs, tables, and oil flotation, and has a capacity of 2,500 tons (24 hours). The shaft at the Roseberry mine is 200 feet deep, and the concentrating plant has a capacity of 500 tons in 24 hours.

VERMONT.

During 1919 copper concentrates amounting to 1,395 tons were shipped from mines in Vermont and yielded 18.24 ounces of gold, 2,214 ounces of silver, and 582,468 pounds of copper, having a combined value of $111,196. All the ore treated was concentrated and yielded 1 ton of concentrates from each 16 tons of ore.

The Eureka mine, near Corinth, in Orange County, which was formerly operated by the Pike Hills Mines Co., was closed early in 1919, after some copper concentrates had been shipped. The mine is opened by an inclined shaft 500 feet in depth and by tunnels, and the chalcopyrite ore is concentrated at a 100-ton plant by selective flotation.

The largest quantity of copper produced in Vermont in 1919 came from the Elizabeth mine of the Vermont Copper Co., near South Strafford, which has a tunnel 800 feet long, an inclined shaft 810 feet deep, and more than 3,000 feet of drifts. The 100-ton concentrating plant is equipped with a Hardinge ball mill, Dorr classifier, Oliver filter, and Callow flotation cells. The crude ore contains about 2.25 per cent of copper, and the concentrates, which are shipped to smelters, contain from 18 to 22 per cent of copper and some silver and gold. The mine and mill were closed early in 1919 and have not been reopened. The property is in excellent condition, and operations could be resumed at small expense and at increased capacity, as the mill equipment has been doubled. The company obtains its power from a hydroelectric plant on White River, but must obtain supplies and ship the copper concentrates by motor, as the mine is 8 miles from the railroads. It was difficult to operate profitably under old freight rates, and unless other costs are lowered or the price of copper rises the increased freight rates are prohibitive.

The Ely mill, near West Fairlee, in Orange County, which was operated by the Ely Copperfield Associates, was closed in December, 1918, but some copper concentrates containing gold and silver were shipped and smelted in 1919. No crude ore from the Ely mine has been mined for many years, and the workings are full of water. There is, however, a large dump of ore averaging 1.5 to 2 per cent of copper, from which the richer ore was sorted for smelting at the property. This old ore has been treated by means of a 100-ton flotation plant for several years, and the supply of such material is ample for many years of operation when the costs are lowered. The workings of the Ely mine are larger than those at any other copper property in Vermont. The ore was smelted at a plant now dismantled.

VIRGINIA.

The mines of the Bertha Mineral Co., at Austinville, and the Helen Mineral Co., at Ivanhoe, in Wythe County, and of the Atlantic Lead & Zinc Co., in Albemarle County, Va., were idle in 1919, and no recoveries of gold and silver were reported from the smelting of pyritic ores. The value of gold produced from mines in Virginia during the period 1828 to 1919 was $3,296,569,[11] of which less than $13,000 has been recovered during the last 10 years. The deep and placer gold mines in Albemarle, Floyd, Fauquier, Goochland, and Fluvanna counties have yielded about half of the total in that period, the remainder of the gold being derived from cinders of pyritic ores or copper ores shipped to smelting plants.

[11] Director of the Mint Ann. Rept., 1919, p. 53.

SECONDARY METALS.

By J. P. Dunlop.

INTRODUCTION.

SCOPE OF REPORT.

"Secondary metals" are those recovered from scrap metal, sweepings, skimmings, and drosses, and are so called to distinguish them from the metals derived directly from ores, which are termed "primary metals." The distinction does not imply that secondary metals are of inferior quality, for metals derived whether from ore or from waste material vary in purity and in adaptability for use in making certain products. The reports to the United States Geological Survey now include the secondary recoveries of copper, zinc, lead, tin, antimony, aluminum, and nickel. The figures obtained by the Survey are given as a supplement to the regular reports on primary metals in order to enable producers and consumers to form a more comprehensive idea of the quantities of metal available for consumption; in fact, they constitute an essential addition to the seven general reports on primary metals, though only a part of the recovery of waste metals is given.

RECOVERY OF WASTE METAL.

NEED OF CONSERVING AND USING WASTE MATERIAL.

The primary collection of waste is in charge of those who make a business of that branch of industry. Practically no waste is now handled by voluntary organizations or individuals other than the Salvation Army, which has for many years collected and sold or used discarded articles, such as newspapers, books, and rags. As there no longer is any urgent necessity to supply quickly material needed for war purposes, it is more economical that the collection, buying, and selling of waste be confined to regular channels which are more conducive to a sustained steady flow of material.

There are ample supplies of both primary and secondary metals, and conservation of new metals on account of their scarcity is no longer imperative. On the other hand, the orgy of reckless extravagance in manufacturing is past; "cost" and not "delivery" is the paramount consideration of purchasers, so that manufacturers are compelled to study the problems of costs. The wages paid for labor will probably not soon decrease materially, and taxes and freights are higher, with no present prospect of reduction, so that decreased costs must be based on cheaper material and better methods of manufac-

ture. One of the methods by which costs can be reduced in the metal trades is by the greater and more efficient use of scrap. It is poor business to use high-grade metal where a lower-grade metal will do. Many consumers of metal products do not know or are indifferent to the fact that orders can be filled satisfactorily under different specifications. Sometimes high-grade metals and alloys are used because custom or precedent is slavishly followed. A generous use of waste material should be cultivated; but all scrap metal must be carefully examined and graded, furnace and foundry practice must be more critical, and more intelligence must be employed if dirty or defective castings are to be avoided, for the use of such material without discrimination is foolish.

The recent scarcity of many primary metals certainly resulted in the more extended use of scrap in making products for which only primary metals had been used. It also brought about the greater use of reclaiming equipment, better handling and segregation of waste metal, and better technical supervision. It is unfortunate, however, that most of the improvement was made at large and prosperous plants, for it is most desirable that the smaller foundries and metal-working establishments make greater use of magnetic separators, riddles, screens, jigs, and tables. If the waste material is too small in quantity for the economical use of reclaiming equipment, it can usually be at least better segregated so that it can be marketed more profitably. In many plants no attention is paid to scrap metals, sweepings, borings, and ashes, and they are neglected until need of space results in their disposal just to get rid of them. In like manner, too little attention is devoted to the question of whether it is better to sell borings and grindings to a dealer or to have them briquetted and used at the plant that produces them.

It is possible to purchase from reputable smelters composition ingot made from scrap which may be used as a substitute for primary metal or for scrap alloys of dubious composition. Competition is keen in the foundry business, and frequently a quarter of a cent a pound loses an order for castings, whereas the margin between the price of ingots made from scrap and the price of virgin ingot metal is seldom as little as a cent a pound.

Study and practice make as much for efficiency as the quality of the material used, and there are many manufacturing plants that could save money by investing in the services of an expert on waste material.

There are dishonest men in all kinds of business, and the waste-trade industry does not harbor more of them than might be expected. Much of the impression that it does arises from the fact that many sellers of waste do not know the value of what they sell, whereas the buyer does know. He must know in order to stay very long in the business. Incidentally, the Association of Waste Material Dealers is quite correct in objecting to the use of the word "junk" instead of "waste" in the trade, for the general public associates the word "junk" with the miscellaneous pile of trash or dirt (for dirt is matter out of place) of the small collector that is properly termed "junk." Once sorted and in the possession of dealers ready for consumption, waste is no longer junk, but material of recognized value and usefulness.

A considerable but unknown quantity of silver is reclaimed from material discarded by moving-picture and other photographic laboratories. A large proportion of a new film is spoiled or cut out before the reel is used, and old films are discarded. This waste film and the solutions containing silver are collected and the silver is recovered. Waste film is also used by manufacturers of celluloid products, who also purchase other celluloid waste from many sources.

Prior to 1914 there was practically no market for old photograph negatives for reuse in photography, as the manufacturers of negative coating claimed it did not pay to recoat old glass; so that many photographers had large accumulations of glass. The waste negatives, however, were occasionally sold for $2 to $3 a thousand and reused by picture framers and clock makers. The cessation of imports from England and Belgium in 1914 and the small supply in the stocks of domestic dealers caused makers of negative glass to experiment with old glass. It was soon discovered that old negatives could be recoated, and thus an active market was created for such glass, with a demand that exceeds the supply.

Many ordinary and some unusual phases of the waste-trade industry, stated in an interesting manner and mainly without the exaggeration that usually embellishes reviews of industries in popular magazines, are presented in an article by Waldemar Kaempffert in McClure's Magazine for June, 1920. A perusal of that article and a glance at any issue of the Waste Trade Journal gives some idea of the large use of waste material in its various ramifications. For many of the numerous classes of waste there are no statistics available, not even for some whose yearly value far exceeds that of many of the well-known metals. Much of the material handled by dealers, such as ferrous and nonferrous metals and alloys, rubber, paper, rags, and bags, is familiar to everyone, though the various classifications and grades of each are not. Among the less familiar waste materials for which there is always a market are bones, old felt hats, rope, leather, celluloid, hair, fur, moss, barrel covers, and window shades.

There are no accurate statistics of the quantity and value of scrap iron and steel resmelted nor of the various ferroalloys that range in price from about $7 to several hundred dollars a ton. It would be possible, though not easy, to obtain accurate statistics of the scrap iron and steel used at furnaces and steel mills, but that information would necessarily require supplemental information from thousands of foundries that use scrap material. The estimates of consumption now made are based on the quantity of scrap handled by large dealers, a method which is far from satisfactory.

The various grades of scrap iron and steel sold at very moderate prices in 1919, compared with the prices of pig iron and steel, especially in view of the fact that the railroads did not supply the usual quantity of scrap and that during the war the whole country had been thoroughly combed for scrap iron and steel to supply foundries unable to obtain supplies of pig metal.

It is estimated by the Waste Trade Journal that the railroads, which normally supply 40 per cent of the iron and steel scrap, supplied only about 24 per cent in 1919. This shortage will be made up when the railroads are able to purchase new rails and equipment.

There has been and is now an abundant supply of scrap metals in Great Britain, which has undoubtedly affected the consumption of new metals. War uses ceasing, millions of tons of material was converted to scrap. Offers of scrap—aluminum, brass, copper, shell bands, cartridge cases, antimonial lead—have been made from firms in Great Britain, France, and Italy. One dealer in England offers for sale 250,000 tons of metallic scrap, including copper shell bands, cartridge scrap, and clean shrapnel bullets.[1] Such offers will help to an understanding of the stagnant market for many new metals in 1919.

SOURCES OF INFORMATION.

The Geological Survey frequently receives letters inquiring as to the treatment of drosses and skimmings and of alloys suitable for certain products and as to other technical matters, to which it is not able to make answer, though it endeavors to indicate where such information may be obtained if it is obtainable. There are trade papers and journals which give the source and nature of waste material and the prevailing prices of all kinds of scrap metals. They also contain replies to many questions relating to remelting, refining, and proper methods of alloying.

To keep in touch with the daily changes of their business world every manufacturer using metals and every buyer, seller, and broker of metals should receive some or all of the daily trade papers. Some of these papers have special representatives in Washington and in other places who promptly report and comment upon all matters that affect metals and products made from metal. In addition to the trade papers, such as American Metal Market, Daily Metal Reporter, and Daily Metal Trade, issued daily, everyone interested in metals should obtain the more comprehensive and technical information given in weekly or monthly trade journals, such as the Waste Trade Journal, Metal Industry, Raw Material, Brass World, Foundry, Iron Age, and Iron Trade Review.

Copies of the separate chapter on secondary metals from Mineral Resources, 1917, which contains an article entitled "Warring on waste," by William Crawford Hirsch, and excerpts on the character and proper use of many scrap metals, are still available and may be obtained from the Director, United States Geological Survey, Washington, D. C. A very useful and comprehensive book by George H. Manlove and Charles Vickers, entitled "Scrap metals," has been published by the Penton Publishing Co., Cleveland, Ohio.

CLASSIFICATION FOR OLD METALS.

The classification for old metals drawn up by the metal division of the National Association of Waste Material Dealers, and changed from time to time as was found desirable, has become the standard all over the United States with both dealers and manufacturers. The latest classification, Circular F, is effective until July 1, 1921, when a new circular will be issued. It was suggested at the regular meeting in June, 1920, that the word "junk" be discarded in all deal-

[1] Metal Bulletin (England), October, 1920.

ings between members and that all stationery should bear the slogan "Not junk—waste material." Aside from drawing up metal classifications, the metal division, as well as all other divisions of the association, has a grievance committee, whose duty it is to adjust differences between members or to arrange for arbitration if it becomes necessary to have such disputes arbitrated. The metal division of the association has in recent years been able to remedy trade abuses, and, as a result of the constructive work accomplished, it has attracted to it practically all domestic metal dealers of importance, and the gain in membership in 1919 was the largest since organization.

Standard classification for old metals, effective from July 1, 1920, to July 1, 1921.

1. Delivery:

(*a*) Delivery of more or less on the specified quantity up to 2½ per cent is permissible.

(*b*) If the term "about" is used, it is understood that 5 per cent more or less of the quantity may be delivered.

(*c*) Should the seller fail to make deliveries as specified in the contract, the purchaser has the option of canceling all of the uncompleted deliveries or holding the seller for whatever damages the purchaser may sustain through failure to deliver, and if unable to agree on the amount of damages, the arbitration committee of the National Association of Waste Material Dealers (Inc.), appointed for this purpose, to determine the amount of such damages.

(*d*) In the event that buyer should claim the goods delivered on a contract are not up to the proper standard, and the seller claims that they are a proper delivery, the dispute shall be referred to the arbitration committee of the National Association of Waste Material Dealers (Inc.), to be appointed for that purpose.

(*e*) A contract for a carload, unless otherwise agreed upon, shall mean the minimum quantity recognized by the official classification tariff of the district in which the seller is located.

(*f*) A ton shall be understood to be 2,000 pounds, unless otherwise specified.

(*g*) If, through embargo, a delivery can not be made at the time specified, the contract shall remain valid, and shall be completed immediately on the lifting of the embargo, and terms of said contract shall not be changed.

(*h*) In case of a difference in weight and the seller is not willing to accept buyer's weights, a sworn weigher shall be employed and the party most in error must pay the costs of handling and weighing.

2. Heavy copper:

This shall consist of copper not less than one-sixteenth inch thick, and may include trolley wire, heavy field wire, heavy armature wire, that is not tangled, and also new copper clippings and punchings, untinned and clean and copper segments that are clean.

3. No. 1 copper wire:

To consist of clean untinned copper wire not smaller than No. 16 B. & S. wire gage to be free from burnt copper wire which is brittle and all foreign substances.

4. No. 2 copper wire:

To consist of miscellaneous clean copper wire such as of necessity would be taken out of the heavy copper and the No. 1 copper wire, but to be free of hair wire and burnt wire which is brittle.

5. Light copper:

Shall consist of the bottoms of kettles and boilers, bathtub linings, hair wire, burnt copper wire which is brittle, roofing copper and similar copper, free from radiators, brass, lead, and solder connections, readily removable iron, old electrotype shells, and free of excessive paint, tar, and scale.

6. Composition or red brass:
   Shall consist of red scrap brass, valves, machinery bearings, and other parts of machinery, including miscellaneous castings made of copper, tin, zinc, and/or lead, no piece to measure more than 12 inches over any one part, to be free of aluminum and manganese, also free of railroad boxes, cocks, and faucets, gates, pot pieces, ingots, and burned brass.
7. Railroad bearing:
   Shall consist of railroad boxes or car-journal bearings, must be old standard used scrap, free of yellow boxes, plastic and similar bearings, also iron-backed boxes, and must be free of babbitt; also free of excessive grease and dirt.
8. Cocks and faucets:
   To be mixed red and yellow, free of gas cocks and beer faucets; shall be at least half red.
9. Heavy yellow brass:
   Shall consist of heavy brass castings, rolled brass, rod brass ends, brass screws, and tinned or nickel-plated brass tubing; to be free of iron and dirt, and must be in pieces not too large for crucibles; no piece to measure more than 12 inches over any one part. Must also be free of aluminum and manganese mixtures. Condenser tubes shall not be considered as heavy brass.
10. Light brass:
    Shall consist of light sheet brass, forks and spoons, miscellaneous brass that is too light for heavy, to be free of any visible iron, radiators, gun shells containing paper, ashes or iron, loaded lamp bases, and clock works.
11. New brass clippings:
    Shall consist of the cuttings of new sheet brass, to be absolutely clear and free from any foreign substances.
12. Brass tubing:
    Shall consist of brass tubing, free of nickel plating, tinned, soldered, or tubes with cast brass connections. To be sound, clean tubes, free of sediment, and condenser tubes.
13. No. 1 composition turnings:
    To be free of aluminum, manganese, plastic, and yellow brass turnings, not to contain over 2 per cent iron, to be free of grindings or foreign material, especially babbitt, and free from adulterations made to resemble metal. Turnings not according to this specification subject to sample.
14. No. 1 yellow brass turnings:
    Shall consist of strictly rod turnings, free of aluminum, manganese, composition, and tobin turnings. Not to contain over 3 per cent of iron, oil, or other moisture, to be free of grindings and babbitts. To avoid dispute, to be sold subject to sample.
15. No. 1 pewter:
    Shall consist of tableware and soda-fountain boxes, but in any case must test 84 per cent tin. Syphon tops to be treated for separately.
16. Auto radiators:
    To be classed separately, must be free from iron.
17. Zinc:
    Must consist of clean sheet and cast zinc, also cast batteries, to be free of loose oxide and dross, sal ammoniac cans, and other foreign materials.
18. Tin-foil:
    Shall consist of pure foil free of lead compositions and other foreign ingredients and matters.
19. Electrotype shells:
    Must be hand picked and free of dross.
20. Battery lead plates:
    Shall consist of dry battery lead plates to be free from wood, rubber, and paper, moisture not to exceed 1 per cent.
21. New sheet aluminum clippings:
    Shall consist of new sheet aluminum and cuttings. Must be free from oil, grease, and any other foreign substances. Must be guaranteed not less than 98 per cent pure aluminum.

22. Aluminum wire:
Shall consist of aluminum wire guaranteed 98 to 99 per cent pure aluminum and must be free from corrosion and any other foreign substance.
23. Painted sheet aluminum:
Shall consist of painted sheet aluminum and must be absolutely free from iron, dirt, or any other foreign substance.
24. Aluminum castings:
Shall consist of aluminum castings, free from iron, babbitt, brass, and any other foreign substance. Must not exceed 2 per cent of oil and grease.
25. Old sheet aluminum:
Shall consist of old and manufactured sheet aluminum. Must be free from painted sheet aluminum, iron, dirt, and any other foreign substance.
26. Aluminum borings:
To avoid dispute, should be sold subject to sample.
27. Aluminum foil:
Shall consist of pure aluminum foil, free from paper, and any foreign ingredients.
28. Babbitt metal:
Shall contain bearing metal of all kinds. Shall not contain scrap hard metal, Allen metal (which is copper and lead alloy), die cast, zinc boxes or type metal.
29. Monel metal scrap:
Must be in sheets, clippings, castings, bars, or rods. Must be free of iron and other foreign materials. To avoid disputes, to be sold subject to sample.
30. Monel metal turnings:
Must be free of iron and undue percentage of oil and moisture. To avoid disputes, to be sold subject to sample.
31. Packages:
Shall be good strong packages, suitable for shipment, and each package to be plainly marked with the gross and tare weights so that when packages reach their destination their weights can be easily checked.
When goods are not packed according to the above specifications and shipper wants his rejections returned, the cost of labor shall be charged to the shipper.

REVIEW OF THE SECONDARY-METAL INDUSTRY IN 1919.

As shown in the table giving the recoveries of secondary metal in 1919, dealers in and refiners and smelters of scrap metals and drosses handled more material containing lead, aluminum, and nickel than in 1918. The quantity of antimony-scrap alloys and drosses was considerably smaller. The recovery of tin as metal was about 1,200 tons less than in 1918, mainly on account of the decrease in the output of tin plate. The tin recovered in alloys and chemical compounds, however, increased nearly 1,300 tons. Owing to the increase in the quantity of galvanized plates and forms in 1919, there was a larger quantity of zinc dross available, and several smelters which had used retorts in 1918 to redistill prime western zinc resumed treatment of zinc drosses. The exports of zinc dross decreased from 15,816 short tons in 1918 to 5,123 tons in 1919. In consequence of these changes in conditions the recovery of redistilled and remelted zinc increased about 12,800 tons. The recoveries of zinc in brass and other alloys was much less in 1919 than in 1918, though this was due mainly to the decreased quantity of clean brass scrap used. There was a large increase in recovered lead as metal and in alloys on account of a shortage of primary spot lead, caused by strikes, lack of fuel, and difficulties of delivery. The high price of tin also created an active demand for scrap babbitt solder and bearing metals.

There was a comparatively small decrease in the quantity of scrap copper reused in 1919, but the quantity of scrap brass utilized was about 79,000 tons less than in 1918. Nearly all this decrease was caused by the cessation of the manufacture of war material.

During most of the year there was much more brass scrap in sight than was necessary to supply the demand. There was a natural diffidence to purchase brass scrap while the quantity of Government holdings of scrap was unknown, and prices were depressed until the bulk of these holdings was marketed. It is probable, however, that a considerable part of both primary metal and scrap metals sold by the Government was not consumed in 1919.

The ordinary channels of supply also yielded considerably more brass and bronze than could be absorbed, as plumbers' brass goods were not actively sought by consumers during the early part of 1919. The demand was better about the end of the year, though there were sufficiently large stocks of scrap brass to cause a serious shrinkage in the domestic demand for copper and zinc. The trade in aluminum scrap and aluminum alloys was good throughout the year because of scarcity of virgin metal.

Scrap-metal prices, 1919, in cents per pound.[a]

[New York dealers' average buying prices.]

Week.	Crucible copper.	No. 1 composition.	Heavy lead.	Scrap zinc.	Week	Crucible copper.	No. 1 composition.	Heavy lead.	Scrap zinc.
January:					July:				
4	17.25	16.00	4.75	5.00	5	16.75	16.00	4.75	5.25
11	17.25	16.00	4.75	5.00	12	17.00	16.50	4.50	5.00
18	17.25	16.00	4.75	5.00	19	18.75	18.25	4.50	5.25
25	16.25	15.25	4.25	4.75	26	20.25	18.75	5.50	5.25
February:					August:				
1	16.00	15.50	4.25	4.50	2	20.25	19.00	5.50	5.25
8	15.75	15.25	4.25	4.50	9	20.25	19.00	5.25	5.25
15	15.25	15.00	4.00	4.50	16	19.25	17.75	4.75	5.25
22	14.75	14.00	4.00	4.50	23	19.75	18.00	4.75	5.25
March:					30	19.25	17.75	4.75	5.25
1	14.25	13.25	4.50	4.50	September:				
8	12.75	12.50	4.50	4.50	6	19.25	17.75	4.75	5.25
15	13.00	12.50	4.50	4.50	13	19.25	17.75	5.25	5.25
22	13.00	12.50	4.50	4.50	20	19.25	17.75	5.25	5.25
29	13.00	12.50	4.25	4.50	27	18.75	17.25	5.50	5.00
April:					October:				
5	13.75	13.25	4.25	4.50	4	18.75	17.25	5.50	6.00
12	14.25	13.25	4.25	4.75	11	18.75	17.25	5.50	5.00
19	13.75	13.00	4.20	4.50	18	18.75	17.25	5.50	5.25
26	13.75	13.00	4.20	4.50	25	18.75	17.25	5.75	5.00
May:					November:				
3	13.50	13.00	4.20	4.50	1	18.75	17.25	5.75	5.25
10	13.50	13.00	4.10	4.50	8	17.75	16.25	5.75	5.25
17	13.75	13.50	4.25	4.50	15	17.75	16.25	5.75	5.25
24	14.50	14.25	4.60	4.75	22	17.25	16.00	6.00	5.25
31	14.75	14.50	4.60	4.75	29	16.25	15.50	6.00	5.25
June:					December:				
7	14.75	14.50	4.60	4.75	6	16.25	15.50	6.00	5.25
14	15.25	15.25	4.75	4.75	13	16.75	15.75	6.25	5.25
21	15.75	15.25	4.75	5.00	20	16.75	15.75	6.25	5.25
28	15.75	15.25	4.75	5.25	27	16.75	15.75	6.50	5.25

[a] Waste Trade Journal, Jan. 24, 1920.

Part of the metal or metals contained in drosses and skimmings and in waste material is undoubtedly recovered and reused several times in one year. New clean scrap is sold and becomes mixed with old scrap

contained in articles that have been used and discarded. New clean clippings of zinc, tin, and aluminum are usually carefully segregated from other scrap metals, but many smelters and many dealers in metals do not keep separate records of other new clean scrap and old used metals. The quantity of the various metals contained in numerous alloys made partly or wholly from secondary material can not be definitely ascertained. The figures given as the result of the annual inquiry made by the Geological Survey are only approximate, but they are the only available data of an important industry.

The value of the secondary metals, exclusive of gold, silver, platinum, iron, steel, and ferroalloys, recovered in the United States decreased from $264,298,900 in 1918 to $181,841,500 in 1919. The decrease was due mainly to the much lower average price of copper, zinc, lead, tin, and antimony, for with the exception of antimony, copper, and brass the quantity of recovered metals was larger in 1919 than in 1918.

The value of the secondary platinum, iridium, and palladium recovered in 1919 amounted to $8,053,265, which was more than the value of the platinum and allied metals imported for consumption in the United States in 1919.

The value of the gold or silver contained in old jewelry, dental waste, silver spoons, tableware, ornaments, and other articles remelted or refined in 1919 was more than $27,592,060. Mints and refineries reported the recovery of 6,463,002 fine ounces of silver and $19,354,398 in gold from waste or discarded material. Jewelry and dental waste are the largest sources of secondary gold, and silverware and photographic wastes of secondary silver. The increased value of silver naturally resulted in the return of large quantities of old used spoons and other tableware to the melters, the remelting of unsold silverware of obsolete patterns in the stock of manufacturers and retailers, and the large increased sales of photographic material resulted in an increased quantity of silver used in that industry. It is difficult to estimate the value of ferrous scrap remelted in 1919. Estimates of the quantity vary from 7,500,000 to 8,500,000 long tons. Owing to the enormous consumption of iron and steel for war purposes there was a large increase in the quantity of scrap ferrous alloys available. A considerable part of the scrap ferrous metal contained nickel, tungsten, manganese, chromium, vanadium, molybdenum, or other alloys, which made it many times more valuable than the ordinary commercial iron and steel scrap, though the market is limited and some knowledge regarding consumers is necessary to locate prospective purchasers. All this high-priced ferrous metal scrap will be absorbed into trade channels, though it will take considerable time to use the large accumulations of nickel steel and other special ferrous alloys, part of which were used only for munitions. The large decline in the sales of primary nickel were no doubt caused by the reduced production of nickel steel and the marketing of nickel-steel scrap. There continued to be a considerable quantity of scrap metals from abandoned steam and trolley railways, but the quantity of old metals marketed by operating railway companies was much less than usual. Buying of new material by railways was restricted to urgent needs, consequently smaller quantities of old rails, car wheels, and other equipment were discarded. The railways are on the whole the largest

producers of most kinds of metal scrap, as well as the largest users of new and remelted metal. It is estimated that the railways usually supply more than 40 per cent of the scrap iron and steel and that in 1919 their sales of ferrous material did not exceed half their normal quantity.

The dealers and brokers in ferrous metals think that the prices paid by users of iron and steel scrap since November, 1918, have not been fair in that they have shown a much greater percentage of decrease than the prices of iron and steel products made from this old material.

It is impracticable and unnecessary to segregate the statistics relating to the melting, refining, and using of secondary metals according to States, but more than 90 per cent of the refining and smelting of drosses and scrap metals in the United States is confined to the territory east of St. Louis and north of the Ohio River. Nearly all the secondary aluminum was reported from Ohio, Michigan, Connecticut, Illinois, Indiana, and Wisconsin. The largest recoveries from tin dross, tin scruff, and clean tin scrap were made in Pennsylvania, New York, New Jersey, and Indiana. Nearly all the secondary nickel was reported from Connecticut. The recoveries of lead, zinc, and copper and of such alloys as babbitt, bronze, brass, and pewter were more generally distributed, though the largest secondary smelters and refineries are in Pennsylvania, Illinois, Michigan, Ohio, and New York. There has been some increase in the last few years in the number and capacity of smelters treating secondary metals in the Southern States, and also in San Francisco, Seattle, and Tacoma on the Pacific coast.

William Crawford Hirsch, former editor of the Waste Trade Journal, and an authority on the secondary-metals markets, reviews the situation ably, as follows:

> The formal ending of the state of war, whenever it does come, will still find the secondary-metals industry subsisting in part on the avalanche of supplies which all but submerged the market as the result of the dispersal of the Government's war-material surplus. As a natural result of this condition the trade's thoughts center in efforts to quicken the demand, ignoring almost completely the problems of collection and supply. And yet ere long the paramount question will again be conservation. A survey of large, medium-sized, and small establishments in which nonferrous metal scrap is produced has convinced me that much of the war propaganda for the salvaging of every possible scrap of metal has fallen upon deaf ears. In the large establishments, where pride is taken in manufacturing efficiency, little scrap goes to waste. For that matter, in these institutions little scrap went to waste in 1916. There we find briquetting devices and other means of careful salvaging and reutilization. So long as copper and zinc scrap sold at war levels, the medium-sized and smaller producers used fairly energetic diligence in saving their scrap. But just as soon as metal values displayed signs of realigning themselves on a more normal basis, the enthusiasm for intensive scrap conservation waned perceptibly, and the formal return to peace will find scrap conservation at a lamentably low ebb. The war has seemingly taught school children the value of saving waste paper, but it does not appear to have awakened hundreds of small manufacturers of brass ware and other finished metal products to the necessity of collecting their cuttings, turnings, and filings in systematic manner and to see to it that these accumulations are clean. When you seek to point out to some of these shortsighted ones that not only do they rob themselves of actual dollars and cents by these slovenly methods, but that, moreover, by depriving the market of every possible pound of scrap they drive the price of virgin metal up against themselves, they invariably counter with the old excuse of the lazy man, "It don't pay for the time."

It is deplorable that the lesson of the war should be lost so soon. The thought that I would bring home to every manufacturer who produces scrap metals (or for that matter any other waste material) is this: "You produce castings or stampings or whatever your finished product may be. You seek to produce these finished commodities as economically as possible, and then to sell them at the best price the market affords. This price you set yourself, your salesmen are not authorized to deviate from it, and it is based not only upon cost of manufacture, but also upon the price of your competitors. But you produce another product—scrap. It represents cost just as much as your finished product. Yet you permit some irresponsible person or one of whom you know nothing to come into your place of business and to offer you for this scrap a price he sets himself. After a vain attempt on your part to raise the price he bids, you accept his offer because the 'junk' looks so untidy around the shop. If you were as careless about your finished product as you are about your by-product (and that is what scrap is) it would seem just as repulsive. You would not sell your finished goods to Tom, Dick, and Harry, even if they did pay cash for it, without a justifiable interest in their reliability and business standing. Why then sell your scrap to some one of whose business standing you know nothing? And what is more, why not study the market for your scrap just as conscientiously as that for your finished product, so that you can yourself set the price for one as you do for the other? Responsible scrap-metal dealers and smelters will have all the more respect for you if you are so well posted on the market as to know the value of your scrap. They would much rather do business with you then, because they know you are well informed as to values, and to be this, is to be reasonable. If one dealer or smelter will not buy your scrap at your price, why not visit others and see if you can not sell to them? Would you sell your finished product to a man at a price below the market just because he happened to make you an offer? No reputable secondary-metal smelter or dealer will take the least exception to just as intensive efforts on your part to get just as good a price for your scrap as for your finished product.

In other words, the task ahead of the secondary-metals industry is the education of the producer. It is upon his being enlightened as to the importance of proper scrap conservation and proper scrap disposal that the supply of the industry is founded. In the secondary nonferrous metal industry is to be observed a gratifying desire to make technical progress. Smelters and refiners of secondary metals are appropriating more funds and are giving more of their personal interest to laboratory research. The dealer, whose activity serves frequently to stabilize a disordered market, still has his rightful place; but the tendency in the secondary nonferrous metal industry is more and more toward the elimination of speculative intermediaries between producer and consumer. Of course some dealers at interior points perform the valuable function of collection. In the case of domestic, farm, and small shop scrap, this collection is as vital a function as that of the refiner. In the ferrous branch of the secondary-metals industry somewhat different conditions prevail. There we still have the speculative middleman, aside from the one who grades and sorts scrap iron and steel. At times both grading and sorting as well as speculative storage until demand appears to be at its best lie in the same hands. The fact, however, that the large steel mills had the opportunity during the war to buy much scrap directly from producers, especially from the railroads, and did not seek to perpetuate this system goes far to show that these long-headed consumers appreciate the value of the middleman's services.

For much of the progress that the secondary-metals industry and the waste-material industry as a whole has made during and since the war it is indebted to enlightened leadership; and now that I am no longer connected with the Waste Trade Journal it is a pleasure to pay tribute to the publisher of that trade organ, Mr. C. H. Lipschitz, who guided the ideas and ideals of the industry during the war in such manner that it was of real service to the Nation and who is now leading it in the same way to intensified usefulness in times of peace.

SECONDARY METALS RECOVERED.

Secondary metals of certain classes recovered in the United States in 1918 and 1919.

	1918		1919	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Copper, including that in alloys other than brass	122,510	$60,519,900	112,400	$41,812,800
Brass scrap remelted	328,800	128,696,300	249,700	75,944,100
Lead as metal	41,146	13,788,200	55,684	12,942,600
Lead in alloys	55,954		66,416	
Zinc as metal	27,108	6,950,600	39,910	6,711,900
Zinc in alloys other than brass and in chemical compounds	11,082		6,062	
Tin as metal	7,142	41,381,000	5,977	29,868,200
Tin in alloys	16,695		18,056	
Antimony as metal	43	1,317,000	48	717,900
Antimony in alloys	5,183		4,351	
Aluminum as metal	6,050	10,113,600	6,017	12,014,600
Aluminum in alloys	9,000		12,674	
Nickel as metal	178	1,532,300	163	1,829,400
Nickel in nonferrous alloys	1,215		2,284	
	.....	264,298,900	.....	181,841,500

SECONDARY COPPER.

The total quantity of secondary copper recovered in 1919, on the assumption that the brass remelted had an average copper content of 70 per cent, was 287,190 short tons, of which 35,643 tons (13,797 tons more than in 1918) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 48,087 tons of pig copper, 28,670 tons of copper in alloys other than brass, and 174,790 tons of copper in remelted brass. These figures indicate a decrease for 1919 of about 18,200 tons of pig copper, of 55,370 tons of copper in brass, and of about 5,710 tons in alloys other than brass. At least 134,500 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that less than 152,600 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. From the reports received it is quite evident that there was a decrease in the quantity of old copper smelted and that there was a much larger decrease in the quantity of clean new copper and brass scrap remelted. The reports from munition factories show an enormous decrease in the quantity of clean scrap remelted, and there was a decrease reported in the quantity of scrap brass from other users. The quantity of scrap brass used amounted to 249,700 tons, and of this at least 143,700 tons was clean new punchings, filings, and clippings.

The value of the copper, both as metal and in alloys, is computed at the average yearly price of 18.6 cents a pound, the average sales price of all marketable grades of new metal.

According to the Bureau of Foreign and Domestic Commerce the exports for the calendar year 1919 of scrap brass and copper fit only for remanufacture were 661 tons of scrap brass and 225 tons of scrap copper, and the imports of scrap copper were 2,109 tons, and of scrap brass 7,933 tons. Many railways sell or turn in the larger

portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries more than 16,000 tons of brass in addition to 960 tons of copper and 636 tons of copper in alloys other than brass. The railway reports, however, frequently include alloys termed "brass," which should more properly be designated "bronze." Some other alloys of copper are known by names that do not typify the metals alloyed.

The following names were recommended at the recent meeting of the American Society for Testing Materials to be used in connection with certain brass, bronze, and nickel alloys of copper.

BRASS.

Yellow brass.—The term "yellow brass" shall be used for zinc-copper alloys only containing from 63 to 80 per cent of copper and having a yellow or brass color. Example: Composition of alloy, zinc, 30 per cent; copper, 70 per cent. Systematic name, zinc copper.

Red brass.—The term "red brass" shall be used for zinc-copper alloys only containing more than 80 per cent of copper in which the color varies from a golden to a copper red. Example: Composition of alloy, zinc, 15 per cent; copper, 85 per cent. Systematic name, zinc copper.

Yellow-red brass.—The term "yellow-red brass" shall be used for zinc-copper alloys only containing from 55 to 63 per cent of copper, in which range the brass has a yellowish-red color. Example: Composition of alloy, zinc, 40 per cent; copper, 60 per cent. Systematic name, zinc copper.

Lead brass.—Brass containing more than 0.50 per cent of lead shall be known as "lead-yellow brass," "lead-red brass," or "lead-yellow-red brass," according to the percentage of copper it contains. Example: Lead-yellow brass, composition of alloy, lead, 1 per cent; zinc, 33 per cent; copper, 66 per cent. Systematic name, lead-zinc copper.

Tin brass.—Brass containing more than 0.25 per cent of tin shall be known as "tin-yellow brass," "tin-red brass," or "tin-yellow-red brass," according to the percentage of copper it contains. Example: Tin-yellow brass, composition of alloy, tin, 0.50 per cent; zinc, 39.50 per cent; copper, 60 per cent. Systematic name, tin-zinc copper.

In alloys in which other metals are added, these shall be designated by the use of the proper prefix or prefixes. Example: Manganese-tin brass, composition of alloy, manganese, 0.50 per cent; tin, 1 per cent; zinc, 38.50 per cent; copper, 60 per cent. Systematic name, manganese-tin-zinc copper.

BRONZE.

Bronze.—The term "bronze" shall be used for tin-copper alloys only, containing more than 50 per cent of copper. In alloys in which other metals are added, these shall be designated by the proper prefix or prefixes: Examples: Aluminum bronze, composition of alloy, aluminum, 3 per cent; tin, 5 per cent; copper, 92 per cent. Systematic name, aluminum-tin copper.

CUPRO-NICKEL.

Cupro-nickel.—The term "cupro-nickel" shall be used for nickel-copper alloys in which copper predominates. In alloys in which other metals are added, these shall be designated by the proper prefix or prefixes. Example: Iron-manganese cupro-nickel, composition of alloy, iron, 1.5 per cent; manganese, 2 per cent; copper, 67 per cent; nickel, 29.5 per cent. Systematic name, iron-manganese-nickel copper.

NICKELENE.

Nickelene.—The term "nickelene" shall be used for nickel-zinc copper alloys only. In alloys in which other metals are added, these shall be designated by the proper prefix or prefixes. Example: Lead nickelene, composition of alloy, lead, 1 per cent; nickel, 5 per cent; zinc, 31.50 per cent; copper, 62.50 per cent. Systematic name, lead-nickel-zinc copper.

In the past large producers of certain virgin metals have paid too little attention to scrap metals; they have not realized that scrap metals such as secondary copper and brass exerted sufficient influence to affect the marketing and prices of new metals. The effect of the vast surplus quantity of scrap metals in 1919 has, however, been significantly shown in the much lower consumption of virgin copper and zinc. Moreover, it is probable that all this surplus scrap was not absorbed even in 1920, and that the market for primary metals will be affected to a considerable degree by it during part of 1921.

The production of copper from secondary sources in 1919 was equal to about 32 per cent of the refinery output of primary copper in the United States from all sources, or about 39 per cent of the primary copper smelted from domestic ore.

Secondary copper recovered, 1919.

	Short tons.
Copper as metal	83,730
Copper in alloys other than brass	28,670
	112,400
Copper from new scrap	34,000
Copper from old scrap	78,400
	112,400
Brass scrap melted:	
New clean scrap	143,700
Old scrap	106,000
	249,700
Copper content of brass scrap (averaging about 70 per cent of copper).	
New scrap	100,590
Old scrap	74,200
	174,790
Total secondary copper:	
From new scrap	134,590
From old scrap	152,600
	287,190
Brass scrap imported	7,933
Scrap copper imported	2,109
Brass scrap exported	661
Scrap copper exported	225

Manufacturers of brass castings, rods, and other products bought sparingly of copper, and offerings of scrap brass and turnings were large. A paper prepared by F. L. Wolf and G. E. Alderson for the annual meeting of the American Foundrymen's Association, held at Columbus, Ohio, on October 4–8, described the methods used by the Ohio Brass Co., Mansfield, Ohio, for reclaiming metal from slag and sweepings. The data given were the result of a study of a week's operations and show the actual costs and the metal recovered at the reclaiming plant. The operations of the plant are divided

into two sections—the preliminary treatment and the concentrating treatment—and flow sheets are given for both sections. The preliminary treatment comprises crushing, screening, and hand picking, by which the heavy metallic material and the bulk of the nonvaluable constituents are removed. The concentrating equipment consists of an elevator, pump, classifier, ball mill, jigs, and slime table. The estimated cost of the equipment for the preliminary treatment is given as $750 and that of the concentrating equipment as $5,200. A Dings separator is used principally for removing iron from shop borings and chips. The same equipment could no doubt be used to advantage in a foundry of much smaller capacity than that of the Ohio Brass Co., and even small foundries should give the refuse containing copper and brass the preliminary treatment in order to reclaim all heavy copper and brass and to remove the excessive quantity of worthless material.

White & Bro. (Inc.), Philadelphia, Pa., makers of brass and copper ingots, made an inquiry as to the most desirable methods of disposing of copper-bearing material from the shipper's viewpoint. A synopsis of the replies received is as follows:

Contract.—Material to be disposed of on a yearly contract: Yes, 17 per cent; no, 83 per cent.

Copper.—To be returned in the form of casting copper, 13 per cent; to be returned in the form of electrolytic copper, 12 per cent; to be paid for on Engineering and Mining Journal quotations, 19 per cent; to be paid for on American Metal Market quotations, 45 per cent; to be paid for on Daily Metal Reporter quotations, 8 per cent; to be paid for on Waterbury average quotations, 3 per cent.

Price.—To be the average of the week of agreement of assays, 72 per cent; to be the average of the week following date of agreement of assays, 6 per cent; to be the average of the six days following date of agreement of assays, 7 per cent; to be the average of the 15 days following date of agreement of assays, 4 per cent; to be the average of the calendar month following date of agreement of assays, 11 per cent.

Smelting charges.—A simplified method of calculating treatment charges (cents per pound of material), 57 per cent; a smelting charge (dollars per ton of material) and refining charge (cents per pound of copper), 43 per cent. An additional charge should be made for sampling and testing small lots: Yes, 67 per cent; no, 33 per cent. A premium should be paid for large lots: Yes, 81 per cent; no, 19 per cent. A premium should be paid for material not requiring special treatment preparatory to smelting: Yes, 88 per cent; no, 12 per cent.

There has been a steady increase at large plants in the use of electric separators to remove iron from borings and scrap, and the use of briquets made from turnings, borings, and light thin clippings has become more common. The Eastern Brass & Ingot Corporation receives such material and returns the briquetted scrap or cast ingots made from briquets, charging a conversion fee for its services.

The General Briquetting Co., New York City, makes installations at foundries and metal-working plants for briquetting small scrap. The substitution of briquets made without any binder and free from iron for turnings, borings, and light thin scrap metal shows the fol-

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lowing advantages: A saving in metal through the decrease in volatilization and oxidation losses; a decrease in time required for melting and the consequent increase in the capacity of the plant; improvement in handling and transportation due to the much smaller bulk; better control of melting conditions, resulting in improved ingots or castings; greater satisfaction and easier work for the working force.

In the melting of washings from material reclaimed from brass foundry ashes a flux must be used unless the washings are very clean, and even in that case a flux is advisable.[2]

The question is frequently asked whether tin and copper are or can be recovered from brass and bronze. Very little if any metal is so recovered in the United States, but German metallurgists were forced to make such recoveries. The following is an extract from a recent article on this subject.[3]

> Just how the German metallurgists succeeded in obtaining or recovering copper from its alloys, brass and bronze, to replace the copper shortage during the war has been very interestingly revealed by a leading German metallurgist.
>
> The problem was to obtain a pure copper from the miscellaneous alloys which the mobilization of copper brought in. Several copper refineries were built in Germany and Austria, notably by the Siemens companies. The brass utilized comprised door brasses, candlesticks, picture frames, taps, weights, crucifixes, etc. The brass was melted down, the zinc oxidized, and the crude copper cast into anodes and treated in the electrolytic refineries. The requisition of bronzes, largely church bells, followed that of brass. The disintegration of the heavy strong bell metal gave some trouble; the bells were inverted, filled with water, and then shattered by exploding cartridges in the water. The bronze was then fused into anodes for electrolysis. The accumulation of stannic acid in the anode mud and in the electrolytic disturbed the electrolysis, and some copper was first lost and recovered contaminated with lead and other impurities. Those difficulties were, however, eventually overcome.
>
> The recovery of tin was another difficult problem. Germany possessing hardly any tin ores, the stannic anode mud had to be reduced to tin, and special attention was further paid to the recovery of tin from bearings metal. Two works were built to work up old bushings, and it is said that they have been very successful and that some works have also managed to economize tin by adopting electrolytic processes in their tin-plating shops.

As the enormous quantity of scrap brass has undoubtedly reduced the consumption of primary copper and zinc in Great Britain and other European countries, the following extracts are made from an article entitled "Handling and melting of brass scrap and swarf."[4]

> As an example of what can be done by the adoption of scientific methods of plant layout and operation for dealing with the very large quantities of mixed brass swarf and scrap, the following details of the plant and working arrangements in a large brass foundry may be of service to any who contemplate the possibility of making use of scrap material for melting down and securing a uniform and thoroughly homogeneous product.
>
> The plant used was not in any way specially designed, in the first place, for a brass-handling plant, but was simply developed in existing buildings as progress was made to meet the insistent demands for ever-increasing outputs. The first essential point always kept strongly in mind was the cutting down to the very minimum of the amount of handling to which the material (received as the raw product) was subjected in its process of treatment throughout its entire bulk during the unloading operation, and accurately weighed on its passage to the previously selected bin, which received a classification number or letter according to the results of the full chemical analysis. Only in this way

[2] Fluxes for washings and grindings: Brass World, vol. 16, p. 108, April, 1920.
[3] Can copper and tin be recovered from brass and bronze? Idem, vol. 16, p. 51, February, 1920.
[4] Primrose, H. S.: Metal Industry (England), vol. 16, pp. 103–104, July 6, 1920.

was it found possible to keep accurate returns of stock which could be balanced each day at the close of the working of the third eight-hour shift, and it also enabled the exact proportions of the materials from the several bins to be blended or mixed in order to attain, through the exact calculations thereby made feasible, the precise analysis of the finished product within the close limits of the specification worked to.

Cleaning processes.—As all sorts and conditions of scrap and swarf were constantly being received, the preliminary treatment consisted of the above-mentioned classification, which was rigidly adhered to in order that different compositions of raw materials might be completely separated and subsequently used in their just proportions. Figure 1 [5] shows a corner of a metal store to illustrate the regular method of stacking in separate heaps, the small-gage tramway intersecting the mass into conveniently arranged compartments, and the whole being served by an overhead transporter for conveying material to the blending bins, also into the metal store for the weighing of the charges, and thereafter into the foundry for the melting operation. The building in the background is the one in which the blending or mixing of the swarf took place, and that on the right hand is the one in which the assorting of the miscellaneous scrap was done. In figure 2 the method of stacking very bulky material, such as large cartridge cases is shown, the corner of this space also being served by the overhead runway for the transporter which dropped the weighed charges for the foundry in the background and also there received the cast produced for conveyance to the next department.

Bulky scrap materials, such as cartridge carriers and Q. F. cases, were used as containers for holding fine materials, such as concentrates, cuttings, strips, and turnings, and then the whole was squeezed down to the minimum bulk in a hydraulic press. Figure 3 shows the type of press used for this operation, and it was of sufficient power to conduct a number of pressings of these cases containing small materials at one time.

In dealing with the Q. F. cases, as well as with the small arms ammunition returns, it was found necessary to carefully examine these by hand, since the former occasionally were found to contain live primers of unexploded charges and the latter sometimes appeared with ball or blank ammunition. These had to be rigorously excluded on account of the damage they could cause if incautiously admitted to the melting house.

All heavy and light scrap was sorted out and analyzed for its proper classification. The heavy scrap could be melted down in weighed charges as it was, although even in this case examination had to be made to insure that explosive material such as the gaine in fuzes was not left in accidentally. Light scrap was stripped of all foreign matter—such as, for example, solder or tin, which was sweated off by passing the scrap metal down through a sloping hearthed gas furnace, such as is shown in figure 4. The melted metal taken off the brass was collected in the front of the furnace and periodically tapped out into molds at the side.

The blending or mixing operation for the swarf was conducted in large bins with the object of equalizing out the different variations in the composition of the material as received and analyzed, to insure the final product being uniform. Further mixing was accomplished by elevating the swarf onto vibrating riddles, which separated the particles from any pieces of scrap, such as partly machined pieces of brass, rod ends, tools, etc., which were always present in large bulks of swarf. Great saving in labor, time, and space was effected by adopting the elevator principle, which, after the first lift is accomplished, enables all the subsequent processes to be undertaken on the material as it falls by its own weight down through the riddles, disintegrating machine, and the magneting machine to the briquetting presses.

After passing through the riddles the swarf was fed into a disintegrator, the arms or beaters of which were revolving at a high speed. This enabled the material to be reduced to a uniform size, which was a very important point to accomplish in order to insure the success of the subsequent operation of briquetting. Figure 5 shows the strong construction of the disintegrating machine, from the bottom outlet of which the swarf drops into the hoppers of the waterfall type of magneting machine. A pair of these electromagnetic machines are shown in figure 6, and by this means the small particles of steel turnings, etc., and even iron nails, are removed from the swarf, as these would

[5] Illustrations not reproduced.

cause trouble in the melting of the brass. An auxiliary type of magneting machine used for smaller quantities of swarf is the drum form shown in figure 7.

The cleaned and now thoroughly mixed swarf was delivered either direct from the magnetic separators onto the table of the briquetting press, or it was elevated from the bins of clean swarf to a hopper feeding the table. A useful form of briquetting plant is shown in figure 8, which is simply a power press with a rotating table. In the table is a number of containers fitted with plungers below, and when these were filled up with swarf they moved round until they came one after the other under the crosshead. There a pressure plate came down onto the top of the container, whilst the plunger was forced up from below by means of a powerful arm. This consolidated the mass so that when it was lifted out of the container by the next operation of the press it was easily handleable. A serviceable form is round briquets of about 4 inches diameter, a supply of these being shown arranged in the boxes in the foreground of figure 8, and also in figure 9, illustrating the charge weighing bench to which these and the other component parts of the charge are conveyed.

For long springy turnings and small pressed sheet-metal caps, etc., it was necessary to adopt a suitable annealing process to make them "dead," so that when they were squeezed or bundled they would remain in their compressed state and not spring apart when taken from the container of the machine. Figure 10 illustrates a convenient form of gas-fired annealing furnace with the door raised to show a charge ready for being withdrawn. The operation of bundling was performed in a power press of the special construction shown in figure 11, or else in an ordinary hydraulic press having a container of suitable size. The products from these bundling machines, as well as from the previously mentioned press dealing with the cartridge cases, are shown in their compressed form in figure 12, the shapes along the back being from left to right as follows: (1) Annealed fuse covers; (2) fine cartridge metal turnings; (3) cartridge carrier collapsed with small cartridge metal trimmings and swarf; (4) old wire after annealing; (5) fine webbing.

All the prepared materials arranged in separate boxes are suitably placed behind a long central weighing bench where the prescribed charges are weighed out and put into the charge boxes along with the necessary flux. The loaded charge boxes were next delivered by the overhead transporter to the foundry charge store, from which they were issued to the individual melter upon the presentation of a check bearing his working number. These charges were either used for melting down in oil-fired crucible furnaces of a capacity of from 100 to 200 pounds or in large coke-fired tilting furnaces of 660 pounds capacity. Figures 13 and 14 show these two different types of furnaces in operation, and they both proved to be extremely efficient in working, as they were kept in continuous operation throughout the week by three daily shifts of eight hours, the only stoppage being at the week ends from Saturday until Sunday evening. Very much lower efficiency is, of course, now obtainable owing to the different hours worked. Three of the small type of oil-fired furnaces were kept continuously going by one melter, and when dealing with the customary 150-pound charge he could keep up an output of one such charge melted down and cast in 35 minutes. For the larger-sized furnaces, which required a melter for each, the charge of 660 pounds could be melted down and cast in a very little over one hour.

On account of melting such large quantities of small swarf and scrap metal there was always considerably more dross formed on the surface of the molten metal in the crucibles than when ingot metal is melted in the same way. Consequently all the pot skimmings and floor sweepings were carefully collected from the foundry floor and weighed up at the end of every shift, then sent to the mill, as seen in figure 15. These sweeps were crushed wet in a ball mill and sent on to the concentrating house, where they were passed to a rotating classifier and delivered onto the surface of separate concentrating tables for the different sizes of particles. Larger scrap pieces, such as the bottoms of broken crucibles and furnace linings after repair, were crushed in a jaw crusher, and the heavy pieces of brass picked out by hand, the smaller pieces being passed into the concentrating house for treatment. By the aid of Wilfley tables, as shown in figure 16, the light earthy particles were washed away, and the fine pieces of metal were collected, then dried and returned to the metal stores for further treatment, such as magneting to remove stray iron, and analysis preparatory to using over again in the charges. In this way they were crushed up in cartridge cases and cartridge carriers and passed on to the foundry for melting again as previously mentioned.

SECONDARY LEAD.

The secondary lead recovered in 1919 amounted to 122,100 short tons, or about 25,000 tons more than in 1918. The secondary lead recovered as pig lead increased about 14,500 tons, and the secondary pig lead recovered by those smelters whose product is mainly primary metal was 5,269 tons more in 1919 than it was in 1918. The quantity of secondary lead recovered in alloys increased from 55,954 tons in 1918 to 66,416 tons in 1919, so that the increase in secondary lead was due mainly to the larger quantity of lead and of alloys containing lead treated by smelters which treat scrap and drosses only. A portion of the recovered lead in alloys was derived from old babbitt, solder, type metal, and white metal drosses. The main sources of secondary pig lead are old pipe, lead cable, battery plates, and lead lining of acid tanks. Regular smelters reported the recovery of 2,154 tons of lead in scrap antimonial lead. It is stated that the manufacturers of toys formerly imported from Europe consume a large quantity of impure and very low-grade lead scrap.

The quantity of scrap antimonial lead remelted by regular smelters was 9 per cent less than that reported in 1918.

The use of lead in batteries has expanded rapidly with the increase in the automotive industry, and a large part of the secondary lead now recovered is obtained from old batteries. The life of a lead battery is comparatively short, and large quantities of battery lead plates are recovered at secondary smelters.

The total output of secondary lead was equal to about 25.3 per cent of the refined primary lead produced in the United States in 1919, compared with 15.2 per cent in 1918. It was exceeded by the output of primary domestic lead in only two States—Missouri and Idaho.

Secondary lead recovered, 1919.

	Short tons.
Secondary lead recovered by smelters that treat mainly ores	12,545
Secondary lead recovered by plants that treat only scrap and drosses	43,139
	55,684
Secondary lead recovered in remelted alloys:	
Lead content of antimonial lead scrap treated at regular lead smelters	2,156
Lead content of drosses and scrap alloys treated at secondary smelters	64,260
Total lead in alloys	66,416
Total secondary lead recovered	122,100
Refined primary lead produced in the United States:	
From domestic ores	424,433
From foreign ore and base bullion	57,787

SECONDARY ZINC.

The output of secondary zinc (including that in brass) in 1919 amounted to 108,404 tons, and equaled 23.3 per cent of the output of primary zinc in the United States in 1919, the same percentage as in 1918. The recovery was 12,186 tons less than in 1918, and all

the decrease was due to the smaller quantity of zinc contained in brass and other alloys recovered, for the recovery from scrap zinc, dross, and skimmings was 12,802 tons more in 1919 than in 1918.

One smelter in New Jersey, one in New York, and one in California, which treat only zinc drosses and skimmings, use large graphite retorts of 600 to 800 pounds capacity instead of the small clay retorts used by smelters treating ore or mixed ore and drosses. The many uses of zinc drosses and skimmings create active competition for their purchase. Considerable zinc is recovered by sweating, and the residues are sold for redistillation. Secondary zinc varies in quality, just as the zinc derived from ore does, but a part of the secondary zinc is reported to be of excellent quality.

The production of zinc from drosses and skimmings made by those zinc smelters that also treat ores was about 2,800 tons more in 1919 than in 1918. The zinc smelters that treat drosses only obtained 8,981 tons of zinc by redistillation in 1919, as compared with 1,987 tons in 1918. These increases were due in part to the stopping of the redistillation of the low grades of zinc in order to meet the demand for zinc suitable for brass used in making war munitions. The quantity of galvanized sheets and forms increased from 640,444 short tons in 1918 to 820,535 short tons in 1919, so that more zinc dross and skimmings were available for redistillation and other methods of recovery and use. The production of galvanized products in 1919 was, however, about 167,000 short tons less than in 1913.

The zinc recovered in alloys other than brass amounted to 6,062 tons, compared with 11,082 tons in 1918. Of the 39,910 tons of secondary zinc recovered unalloyed, 19,748 tons was obtained by redistillation from drosses and skimmings. Of this quantity 10,767 tons was obtained by smelters whose principal source of zinc is ore. This was about 2,836 tons more than the recovery from drosses and skimmings in 1918. The quantity of zinc recovered by sweating and resmelting increased from 17,190 tons in 1918 to 20,162 tons in 1919. In addition to the 39,910 tons of remelted and redistilled zinc it is estimated that at least 41,500 tons of zinc chloride was made and likewise 79,619 tons of the zinc pigment lithopone (containing approximately 22 per cent zinc sulphide and oxide). The zinc used in both of the last-named products is derived largely from zinc ashes and skimmings, and it is estimated that the zinc content of skimmings and ashes so used was 17,100 tons. The export of zinc drosses, which amounted to 2,536 tons in 1914, 4,167 tons in 1915, and 48 tons in 1916, increased to 13,302 tons in 1917 and 15,816 tons in 1918 and decreased to 5,123 tons in 1919. The zinc obtained by redistillation increased from 9,918 tons in 1918 to 19,748 tons in 1919, and the zinc recovered in brass decreased from about 82,400 tons in 1918 to 62,432 tons in 1919.

Used galvanized-iron scrap and new galvanized clippings are degalvanized by the niter cake process, and the zinc coating is marketed as zinc carbonate or zinc sulphate. It is stated that some of the plants have had difficulty in profitably marketing the zinc compounds produced from the scrap. A large part of the secondary zinc which is not recovered by redistillation is obtained from what is termed zinc dross or galvanizer's dross, which is merely an alloy of

iron and zinc that sinks to the bottom of the kettle and is removed from time to time. It is an alloy of zinc with more than 3 per cent of iron, which makes the zinc thick. This thick zinc is refined by melting it in a kettle, getting it sufficiently hot to be fluid and then introducing by means of a phosphorizer a small quantity of a mixture of chopped potatoes, sulphur, and leather. The dross rises to the top and is skimmed off and the iron forms a sulphide matte which sinks to the bottom of the kettle. The operation is repeated several times, and the result is that the zinc is purified of the iron. As the zinc is now oxidized, it is deoxidized by the introduction of aluminum, about 1 per cent being sufficient. This method produces an excellent grade of zinc, that will run under 0.25 per cent of iron and will be over 98 per cent pure.

Two plants in San Francisco are making zinc dust from zinc dross, so that all that material has a good market; but none of the secondary plants on the Pacific coast treat zinc ashes or skimmings, and it is necessary to ship them to eastern plants for treatment. The high-grade zinc dust is used at domestic and foreign gold and silver mines to precipitate the metals from cyanide solutions.

Secondary zinc recovered, 1919.

	Short tons.
Zinc recovered by redistillation:	
By plants that also treat ores	10,767
By plants that treat only secondary material	8,981
Total redistilled	19,748
Zinc recovered by remelting, sweating, etc	20,162
Total zinc recovered unalloyed	39,910
Zinc recovered in alloys other than brass	6,062
Zinc recovered in brass (estimated)	62,432
Zinc chloride made in 1919, of which 26,250 tons was made from zinc ashes, skimmings, etc	41,500
Zinc content of skimmings and ashes, recovered in chloride	6,500
Lithopone made in 1919, of which 53,000 tons was made from zinc ashes, etc	79,619
Zinc content of zinc ashes and skimmings recovered in lithopone	10,600

SECONDARY ANTIMONY.

The production of secondary antimony, of which all but 48 tons was recovered in alloys, decreased from 5,226 short tons in 1918 to 4,399 short tons in 1919. The value assigned is arbitrary and is based on the average yearly price for ordinary brands of antimony published by the American Metal Market. The regular smelters reported the recovery of 301 tons of antimony contained in 2,456 tons of antimonial lead scrap. The principal materials refined or remelted which contained antimony as an alloy were hard-lead drosses, babbitt, battery plates, solder, pewter, and type metal. Antimony used in the rubber, glass, enamel, paint, and ceramic industries and also for war uses does not yield any secondary recoveries. The quantity of antimony used for shrapnel bullets and for primers naturally declined in 1919, and that used for coloring rubber and for pigments has materially increased in the last three years. The imports of antimony as metal in ore or as oxide or salts in 1919 amounted to 7,972 short tons, a decrease of more than 50 per cent;

and the recovery from secondary sources was equal to 55 per cent of the imports. There was no reported production of antimony from domestic antimony ore in 1919, and the antimony content of antimonial lead of domestic origin in 1919 was 1,336 tons, or equal to about 30 per cent of the quantity recovered from secondary sources.

Secondary antimony recovered, 1919.

	Short tons.
Antimony recovered (mainly in alloys)	4,399
Antimony imported as metal, in ore, or as oxide or salts	7,972
Antimony produced from domestic antimony ores, 1918	127
Antimony produced from domestic antimony ores, 1919	None.

SECONDARY TIN.

Although the United States consumes more than 50 per cent of the world's output of tin, apparently only 86 tons of domestic tin ore containing 56 tons of metallic tin was smelted in the United States in 1919. All this ore was produced in Alaska, mainly in the York district. The American Smelting & Refining Co. imported and smelted tin concentrates from Bolivia at its plant in New Jersey. Tin concentrates from Bolivia were also smelted in electric furnaces by the Andes Electin Co., of New York. The new plant of the Williams Harvey Corporation, on Jamaica Bay, Brooklyn, N. Y., was first operated in November, 1918. These three smelters made an output of about 12,000 short tons of tin in 1919. In 1920 the Seaboard Metal Co., of Arlington, N. J., smelted tin from imported ores.

The secondary tin recovered in 1919 was equal to about 42 per cent of the tin imported, as metal, in ore, into the United States during the year (56,879 short tons). The secondary tin recovered increased from 23,837 tons, valued at $41,381,000, in 1918, to 24,033 tons, valued at $29,868,200, in 1919. The quantity recovered as tin was 5,977 tons and that in alloys and chemical compounds 18,056 tons. The value of the recovered tin here assigned is arbitrary and is based on the yearly average price (62.14 cents) for 99 per cent metal, with prompt delivery at New York, given by the American Metal Market. The secondary tin in alloys increased 1,361 tons and the secondary pig tin decreased 1,165 tons.

Nearly all clean tin-plate scrap is detinned by one of three processes—the electrolytic alkali, the chlorine, or the alkali saltpeter.[6]

By the first process the tin is recovered in the form of a spongy granulated precipitate, which can be remelted into pig tin; by the second process tetrachloride of tin is recovered for use in silk dyeing and weighting; and by the third process the tin is recovered as an oxide, which is either used as coloring in the enamel industry or is melted into pig tin by means of a reverberatory furnace.

A patent[7] (U. S. patent 1310381, dated July 15, 1919) has been granted to Daniel A. and Sidney H. Wilcox, of Garden City, N. Y., for a method of separating iron and tin based upon the fractional distillation of their chlorides. The scrap to be treated is compressed and heated to a temperature bringing a vigorous reaction

[6] A short history of the detinning industry: Met. and Chem. Eng., August, 1917, pp. 187–189.

[7] Daily Metal Reporter, Sept. 13, 1919.

when chlorine is passed over the metal, both metals being volatilized as chlorides. The scrap may be melted and the chlorine passed through or over the melted metal contained in a Bessemer converter, reverberatory, cupola, or blast furnace, electric melting furnace, or muffle furnace. By either method the mixed chlorides are separated by fractional condensation and the tin chloride may be converted into metallic tin or tin oxide. The ferric chloride is dissolved in water, reduced to ferrous chloride by passing the solution over hot iron, and electrolyzed, insoluble electrodes being used, so that the products are pure iron (some occluded hydrogen is present, but this may be removed by heat) and chlorine gas, which may again be utilized.

The recovered tin in alloys included the tin content of products made in several plants from clean tin-plate scrap and 6,997 long tons of old tin-coated cans. This included some tin oxide and putty powder, but consisted mainly of tin tetrachloride and tin bichloride. The production of these compounds is calculated as metal and not separately stated, in order to avoid disclosing confidential information. As the products are made from scrap tin and thus conserve the primary metal, they are properly regarded as recovered tin.

The largest recoveries of tin were made from the scruff and drosses that occur in making tin plate and terneplate and amounted to more than 4,000 tons. The quantity of tin plate and terneplate made in 1919 was probably 370,000 long tons less than in 1918.

About 3,400 tons of tin was recovered from clean scrap tin plate, either as pig tin or as tin chloride or tin oxide. Apparently only about 400 tons of pig tin was recovered from scrap tin (not tin plate), clippings, old tin pipe, tin foil, and collapsible tubes, and it is impossible to give separately the quantities of tin recovered from these sources. Old block-tin pipe is most acceptable scrap, but the quantity available is steadily declining.

All the 5,886 short tons of tin-plate scrap imported in 1919 came from Canada. The tin coating and solder were sweated from a very small quantity of old tin-coated containers, and the black plate was then remelted to make sash weights. In the last three years the cost of collection and the high prices of fuel and labor precluded the use of old cans by sash-weight makers, except for an insignificant quantity obtained directly from the users of the contents packed in tin-coated containers. Very rarely when old cans were used to make sash weights was any attempt made to recover the tin.

Tin-coated scrap and old cans are frequently utilized in western mining regions for their iron content in the precipitation of copper from mine waters; the tin coating, however, is wasted. No old cans are detinned in the Western States, and nearly all the clean tin-plate scrap from can-making plants is shipped to eastern plants under yearly contracts. A small portion of the clean tin strips cut from sheets is sold to makers of boxes and baskets and is used to bind, strengthen, or fasten the tops of the containers made.

A large quantity of tin was recovered in bronze, and part of the brass remelted contains a little tin and lead, which in the aggregate amounts to a considerable quantity, though in 1918 and 1919 every effort was made to substitute other metals or to use a smaller percentage of tin in such alloys. Other alloys from which secondary tin

was recovered were solder, babbitt, pewter, terne metal, and electrotype metal.

From reports received by the Geological Survey approximately 176,450 long tons of clean tin-plate scrap was detinned in 1919, which was about 10,000 tons more than in 1918. This scrap and 6,997 long tons of old cans yielded 8,975,576 pounds of tin oxide, tin bichloride, and tin tetrachloride containing 3,994,080 pounds of tin, also 2,797,073 pounds of tin as metal. About 7,000 long tons of old tin-coated containers was used, from which metal and tin chloride containing altogether 182,498 pounds of tin was recovered. The average metallic content of the tin oxide was given as 78.9 per cent, that of the tin bichloride as 21 per cent, and that of the tin tetrachloride as 45.4 and 46 per cent.

The average recovery, in terms of metallic tin, per ton of clean tin-plate scrap treated in 1919, was 35.75 pounds, and the average recovery from old tin-coated cans was 26.09 pounds. The relatively small quantity of secondary tin recovered from tin-plate scrap and old tin-coated cans is significantly shown when compared with the quantity of tin used in making tin plate. It is estimated that 21,000 tons of tin was used by makers of tin plate in 1919, and that the total recovery of tin as metal and in compounds from tin-plate scrap and old cans was 3,496 short tons, and that of this quantity only 91 tons was obtained from old cans. This shows that considerably less than 1 per cent of the tin used in making tin plate was recovered from old cans.

A small quantity of old cans was used by makers of window-sash weights from which no tin was recovered, but more than 99 per cent of all the old cans utilized in 1919 were treated by the dry chlorine process at plants in New Jersey and at East Chicago, Ind., owned by the Metal & Thermit Co., and by the electrolytic process at plants at Sewaren, N. J., and Streator, Ill., owned by the Vulcan Detinning Co. Most of the cans were received under old contracts and mainly from contractors gathering garbage and waste, which was handled by means of picking belts. The cans purchased were classified as follows:

Class 1. Unused empty and unrusted tin cans not exceeding the 1-gallon size, with or without labels attached, but otherwise free from foreign material such as ice, water, ashes, paint, varnish, white lead, and similar insoluble (in water) contents.

Class 2. Used cans not exceeding the 1-gallon size and otherwise as described in class 1.

Class 3. Used empty and unrusted tin cans exceeding in size the 1-gallon size, but not exceeding the 5-gallon size and otherwise as described in class 1.

Each class should be packed separately and shipped in quantities weighing not less than 5,000 pounds net. In order to facilitate handling and to save space it is advisable to crush or bale the cans. Care must be taken that the cans are not flattened entirely. A spacing of one-half to three-quarters of an inch should be left between the sides of the cans so that they can be cleaned and treated. During 1919 the quoted prices for old tin cans were $10 to $11 a long ton (2,240 pounds) delivered at Sewaren, N. J., Chrome, N. J., and East Chicago, Ind.

The largest purchaser of old cans and scrap tin plate was the Metal & Thermit Co. The efficient plant of this company at Chrome, N. J., consists of separate units for scrap tin plate and for cans. The old cans are dumped directly from the cars into pits, where

they are hoisted on conveyers, washed in alkali solutions to remove all paper, paint, and dirt, then compressed into oblong billets, and placed in steel baskets. The baskets are placed in drums, and the tin is removed by means of chlorine. The capacity of the plant is increased by treating the cans under pressure, and the recovery of tin is more efficient. Very dirty lacquered or painted cans require a stronger solution to remove the coatings, and occasionally some of the tin is lost in cleaning them. The bundled scrap, after it is detinned, is dried and loaded on cars. This steel scrap can be used by steel plants, as it is practically free from tin. It is compressed into blocks, and in that form the smelting losses are reduced.

New tin-plate clippings were treated at the above-named plants that treated old cans, and also by the Johnson & Jennings Co., of Cleveland, Ohio, and the Republic Chemical Co., of Pittsburgh, Pa., which is now controlled by the Vulcan Detinning Co. The companies named are the only ones in the United States that reported the detinning of tin-plate scrap or used tin-coated containers.

The plants now completed and utilizing old tin cans have never received shipments large enough to operate steadily at full capacity even when the prices of tin and black sheet-steel scrap were 50 per cent higher than those prevailing in 1919. The increased cost and scarcity of unskilled labor and the higher cost of cartage and freight have made it unprofitable for collectors of waste material to segregate and ship old cans, so that many contracts with detinning companies were not renewed in 1919. The detinning companies have reduced the price paid for old cans because their expenses of operating have increased and tin has declined to less than 40 cents a pound in October, 1920, and bundled black-plate scrap brings less than $9 a long ton. The supply of tin chloride, which is the main product of detinning plants, is ample since war uses have ceased; in fact, a considerable quantity of tin tetrachloride has been reclaimed from hand grenades.

The detinning plants treating old cans can handle more than 25,000 tons of cans a year—nearly four times the quantity treated in 1919—and it is doubtful if the consumption in 1920 will be more than 20 per cent of that capacity. The supply of used cans has been steadily decreasing as contracts expired, and this will necessitate the closing of some plants, for the margin of profit is small, and steady operation is required to make any profit. Old tin cans do not sell for more than $9 to $10 a long ton delivered at detinning plants, and thus they bring the shipper only $3 to $4 a long ton after loading and freight charges are paid. The only feasible method of obtaining a steady supply of cans is by a reduction in the cost of handling. This can be effected by municipal laws requiring clean, rustless cans to be segregated by the householder and to be dumped by the collector directly into cars or into a baling machine. As the price of tin has declined to a very low point, unless the cost of common labor decreases materially or the methods of collecting the cans are changed, there will be no recovery of tin and steel from used containers. No garbage contractor can afford to sort and ship old cans at prices that would enable detinning plants to use them, especially since freight rates have increased. The doom of the detinning of old cans is sure unless municipalities so regulate the collection of

garbage that the cans must be segregated by the householder, clean and dry, ready to be shipped by rail without any sorting. The collection of tin foil and old collapsible tubes largely by persons and organizations for charitable purposes has also become less effective, because much of the foil and many other containers are either not now made from tin or contain only a small quantity of tin. Small quantities of foil made from lead, zinc, or aluminum are not of much value and do not pay for the trouble of saving and selling. Considerable quantities of block-tin pipe were used in saloons, and the abolition of the liquor business made available considerable tin from the scrapping of bar fixtures. Most of this scrap was marketed during the period of high prices for tin, and very little tin pipe now reaches dealers in waste material. Probably not more than 500 tons of tin was derived in 1919 from all the old tin pipe, collapsible tubes, and tin foil marketed.

Although there is now a supply of tin sufficient for all requirements at nearly pre-war prices, there are two good reasons for restricting its use to the lowest point. One is that the supply of new tin is derived almost entirely from foreign sources, and the other is that tin is a relatively high-priced metal and the use of substitutes giving approximately equal efficiency radically reduces the cost of many alloys, such as solder, babbitt, and other bearing metals. The lower price of tin in 1920 is at least partly due to the lessened quantity of tin used in solders and babbitts and for tin plate, but a contributory cause was the large quantity of bronze and brass scrap containing tin which was available for remelting. A number of interesting and valuable papers[8] on the conservation of tin were read and discussed at the meeting of the American Institute of Mining Engineers held at Milwaukee, Wis., in October, 1918. The articles include the following:

Bronze-bearing metals, by G. H. Clamer.
Pennsylvania Railroad antifriction and bell metals, by F. M. Waring.
The tin-plate industry, by D. M. Buck.
The aluminum bronze industry, by W. M. Corse.
Bronzes, bearing metals, and solders, by G. K. Burgess and B. W. Woodward.
Babbitts and solders, by G. W. Thompson.
The cadmium supply of the United States, by C. E. Siebenthal.
Solder, its use and abuse, by M. L. Lissberger.

Secondary tin recovered, 1919.

Tin recovered as pig tin	short tons	5,977
Tin recovered in alloys and chemical compounds	do	18,056
		24,033
Clean tin-plate scrap treated, including 4,989 long tons imported	long tons	176,451
Old tin-coated containers treated	do	6,997
Metallic tin recovered at detinning plants	pounds	2,797,073
Tin content of tin tetrachloride, tin bichloride, and tin oxide made by detinning plants	pounds	3,994,080
Total tin recovered at detinning plants	do	6,791,153

[8] Am. Inst. Min. Eng. Trans., December, 1918.

Tin tetrachloride, tin bichloride, and tin oxide made at detinning plants	pounds	8,975,576
Average quantity of tin recovered per long ton of old tin-coated containers	pounds	26.09
Average quantity of tin recovered per long ton of clean tin-plate scrap	pounds	35.75
Tin imported as metal in 1919	short tons	44,849
Tin concentrates imported	do	19,196
Tin derived from domestic ores in 1919	do	56
Percentage of secondary tin recovered to tin imported as metal in ore, or as oxide		42.3

SECONDARY ALUMINUM.

The recovery of secondary aluminum as pig aluminum or in alloys in 1919 amounted to 18,691 short tons, valued at $12,014,600, compared with 15,050 tons, valued at $10,113,600, in 1918. The quantity recovered in alloys amounted to 12,674 tons.

Some of the larger secondary smelters and refiners of aluminum in 1919 were the Peninsular Smelting Co., Detroit, Mich.; United Smelting & Aluminum Co., New Haven, Conn.; United States Reduction Co., East Chicago, Ind.; Great Western Smelting & Refining Co., Chicago, Ill.; Cleveland Electro Metals Co., Cleveland, Ohio; Loewenthal Co., Chicago, Ill.; National Smelting Corporation, Cleveland, Ohio; W. F. Jobbins Co. (Inc.), Aurora, Ill.

Various products are made by smelters and refiners from scrap aluminum. One sample of pig aluminum, which was made from clean sheet-aluminum clippings, shows the following analysis:

Analysis of secondary aluminum.

Aluminum	98.75
Copper	.16
Silica	.11
Iron	.56
Manganese	.42
	100.00

Secondary aluminum recovered, 1919.

Secondary aluminum recovered	short tons	6,017
Aluminum recovered in alloys (mainly No. 12)	do	12,674
		18,691
Value of primary aluminum produced in the United States in 1919		$38,558,000
Aluminum (crude and manufactured) imported for consumption	pounds	13,852,065
Aluminum exported as pig aluminum and manufactured articles	pounds	7,165,782

Approximately 97 per cent of the aluminum used in alloys is in No. 12 alloy, containing 92 per cent of aluminum and about 8 per cent of copper, though it usually has an iron content of approximately 1 per cent. Other metals alloyed with aluminum are magnesium, zinc, tin, and manganese, but the total quantity of alloys made from aluminum and these metals is very small compared with the alloys of aluminum and copper in various proportions. A large quantity of No. 12 secondary ingots is made by smelters from old or defective castings, borings, and scrap, as is shown by the fact that the second-

ary recovery of aluminum in alloys was double that recovered unalloyed in 1919.

The following interesting article by Robert J. Anderson,[9] metallurgist, United States Bureau of Mines, was recently published.

CASTING LOSSES IN ALUMINUM FOUNDRY PRACTICE IN THE UNITED STATES.

In founding any kind of castings, even with the best practice, scrap castings are produced because of rejections for certain defects. Casting losses are a serious source of financial loss in iron and steel foundry practice, as well as in brass and bronze, but they are particularly serious in aluminum foundry work because of the high value of aluminum. The indications are that in many aluminum foundries in the United States the casting losses are at times high, and in some plants they are entirely too high when compared with average practice. Of course, defective castings may have a residual value for remelting, but if much machine work has been done on a casting before it is scrapped the labor costs alone may exceed the value of the metal and even that of the rough casting.

In a foundry the monetary losses incurred through the production of waster castings can be ascertained from calculations based upon adequate scrap-loss reports. Such reports when properly kept and interpreted are a valuable aid in finding foundry costs, but they are primarily useful in diagnosing the causes for casting losses. Many aluminum foundries in the United States do not keep adequate records of scrap losses; as a result the causes for defective castings can not be traced, nor preventive measures adopted. However, some of the large aluminum foundries keep excellent records, and it has been found that these involve little extra expense for clerical work. If a foundryman will study his daily production of defective and waster castings he will be able to trace the causes for losses and then make such corrections in his plant practice as will effect a considerable reduction in these losses—as much as 50 per cent in some foundries. If all the present casting losses of the United States could be reduced 50 per cent by eliminating only the readily preventable defectives, a saving of several million dollars would accrue. In the aluminum foundry industry alone the saving would amount to about $600,000.

During the recent war, losses in the production of light aluminum alloy sand castings for the Liberty, Hispano-Suiza, Curtiss, and other aircraft engines were uniformly high, particularly in the founding of crank cases and oil pans. Casting losses in the production of cam-shaft housings, intake and exhaust manifolds, and carburetor bodies were reasonably low; but the size and complexity of most of the aircraft engine crank cases (upper and lower halves) caused serious foundry difficulties. The chemical and physical requirements for aluminum alloy aircraft castings were not difficult to meet, but the rigid inspection and salvage specifications caused losses which were much higher than those usually experienced in the manufacture of commercial automotive castings. Rejections of crank cases and oil pans for the Liberty motor were as high as 50 per cent at times in some large foundries, with an indicated average casting loss of about 30 per cent for all plants.

In the production of light aluminum alloy castings to meet rigid specifications higher losses must be expected than where no specifications, or only lax ones, are in force. Some of the difficulties in connection with the manufacture of aircraft castings during the war arose from labor troubles, lack of competent molders, lax supervision, and the general stress of the times; but many of the defects in rejected castings were traced to avoidable causes, which in turn were the result of inadequate supervision.

Defective castings can be classified according to the kind and amount of the defects, but to determine exactly why a certain defect occurred is a more difficult matter. The castings from a day's run in a foundry may be divided into (1) good castings; (2) castings with remediable defects, which can be salvaged by welding, soldering, or other repairing; and (3) totally defective castings. Whether a casting is rejected will depend upon the kind and amount of the defects, the use to which the casting is to be put, the amount and character of the subsequent machining in relation to the defects, and the rigidity of the specifications. A defect which causes one type of casting to be thrown out may be regarded as trivial or of no consequence in another type of casting.

[9] Brass World, vol. 16, pp. 238–239, August, 1920.

Light aluminum alloy sand castings may be rejected for defects resulting from one or a combination of causes, including cracks, sand holes, chill blows and core blows, cold shuts, hard spots, porosity, leaks, and general unsoundness, uneven walls and core shifts, hard and soft ramming, breakage on trucking, handling, chipping and cleaning, cracking on welding, cope drop, short pour, dirty and broken cores, and sand or paste in the cores, run out, molds crushed in core setting, gates washed in, poor patching, wet sand, draws and shrinkage, warping, broken molds, and inferior metal. On account of the large number of variables in foundry practice it is at times difficult to trace the exact causes for specific defects. However the factors that will most likely cause defects in the castings can be classified; then it will be easier to trace the defects to a definite cause or combination of causes. By eliminating the causes the defects will disappear. Admittedly this is not always easy to do, but the first step to be made in attempting to reduce casting losses is a thorough diagnosis of the causes for defects.

A recent survey of the aluminum-foundry industry by the Bureau of Mines has made data available regarding the losses sustained in the United States in the production of all kinds of commercial light aluminum alloy castings. The average casting loss, including rejections of all kinds on the foundry floor, in the inspection department and machine-shop returns, may be placed conservatively at 10 per cent. Variations in losses, as reported to the bureau by numerous foundries, range from 0 to 75 per cent. No variation of losses is rare except for certain types of exceedingly simple castings, whereas 75 per cent is altogether too high. The indications are that an average figure of 10 per cent for all kinds of castings is approximately correct, although possibly a trifle low when referred to actual production records furnished by some representative foundries.

Figures for losses have been obtained for the production of a wide variety of commercial light aluminum-alloy castings, including automotive castings. The highest average losses are in the manufacture of automotive castings, with vacuum-cleaner parts second and cooking utensils next.

About 97 per cent of the output of sand castings is poured from an alloy containing about 92 per cent aluminum and 8 per cent copper, known in the trade as No. 12 alloy. The rest of the output is cast from various alloys, including different kinds of binary aluminum-copper alloys, aluminum-magnesium alloys, and aluminum-zinc alloys, and ternary aluminum-copper-manganese alloys, aluminum-copper-tin alloys, aluminum-copper-zinc alloys, and aluminum-manganese-zinc alloys. Also some exceedingly complex alloys are cast, but these make a small percentage of the total output.

The total output of light aluminum-alloy sand castings of all kinds in the United States in 1919 is placed at 81,000,000 pounds. The cost of scrapping a pound of rough castings may be placed at $0.125, although variations are from $0.10 to $0.25. On the basis of the figures available, the total monetary values of the losses incurred annually in the United States because of the rejection of defective castings may be readily calculated.

A considerable quantity of scrap aluminum is purchased directly by foundries instead of being purchased and refined by secondary smelters. For this reason it is deemed advisable to reproduce the following article by Charles Vickers.[10]

SCRAP ALUMINUM.

New sheet-aluminum clippings must consist of new sheet aluminum and cuttings, must be free from oil, grease, and any other foreign substances, and must be guaranteed not less than 98 per cent pure aluminum.

When sheet aluminum is compressed into briquets little difficulty is experienced in using it for making aluminum castings, but it is difficult material to melt when loose, as the crucible contains only a small amount at each charge. A great deal of attention, therefore, is required, and considerable metal always is spilled into the furnace. Hence sheet clippings should always be shaped into massive forms. It is fairly good material for making castings when it has a purity of 98 per cent, but it is similar to aluminum wire in that respect, as the specifications for this material require a purity from 98 to 99 per cent also. Aluminum wire is not difficult to charge for melting, provided that when cut into

[10] Daily Iron Trade and Metal Market Report, August 12, 1918.

suitable lengths it is not permitted to untwist if it be in the form of cable. Wire of single strand has to be coiled or compressed into bundles; otherwise it is a most tedious operation to melt it into ingots or castings.

The cost of melting aluminum clippings or wire will depend upon their physical condition. In the case of loose wire in short lengths, produced by the untwisting of cut aluminum cable, the melting cost in a careful test of 500 pounds of wire amounted to $2.62 per 100 pounds, and this was when labor was much cheaper than now. Included in this cost were labor, crucibles, fuel, and loss, but the labor cost was more than all the other costs combined. The loss was 7 per cent. It will be realized that if finely divided aluminum is to be melted economically, some method of forming it into packages of massive size is essential.

The metal, either wire or clippings, forms a good basic metal for ordinary castings and can be alloyed the same as the ingot metal. But owing to the presence of a considerable amount of impurities, trouble from excessive shrinkage of the alloys is likely to arise more often than would be the case if pure aluminum were used. Unless the material be in good shape for charging into the pots, its cost when melted would be near that of pure aluminum ingot, and this must be taken into consideration when deciding upon the particular kind of raw material to use for the work in view.

The temperature of the aluminum should be kept at about a red heat, and after the crucible is as full as desired a flux of zinc chloride should be used to disentangle the oxide from the metal.

The scrap metal specifications insist that aluminum castings shall be free from iron, babbitt, brass, and any other foreign substance and must not exceed 2 per cent of oil and grease.

Aluminum alloys may be divided into two groups, those that contain zinc and those that do not. The first group may contain any amount of zinc from 1 or 2 per cent up to 30 per cent, with or without copper. The second group consists of alloys of copper and aluminum, with rarely more than 8 per cent copper, this latter alloy being known as No. 12 aluminum. Since both these groups are used indiscriminately for making aluminum castings, it is obvious that an assortment of scrap will contain alloys both with and without zinc content. The result is that when melted it is impossible to keep the composition at all regular. Consequently, this chance must be taken when using this type of scrap metal.

Aluminum zinc alloys are not considered suitable for certain classes of aluminum castings, although in general they are stronger than the alloys of aluminum with copper. The aluminum zinc alloys shrink and check more than the aluminum copper alloys; and the higher the content of zinc in the alloy, the more the tendency to shrink, until with over 30 per cent of zinc a peculiar shrinkage trouble is likely to manifest itself on the lower parts of castings of heavy section. The result is that zinc is considered most undesirable in scrap aluminum, and if some easy and inexpensive method could be devised whereby the zinc could be eliminated from aluminum scrap it would be a boon to the scrap metal trade. The best that can be done at present is to alloy the aluminum with zinc-free metals to bring the zinc content down to a point where, while undesirable, it is not harmful for most purposes.

For special purposes, scrap aluminum castings are undesirable, but examples of castings where this material can be used to good advantage are numerous, as it is considerably cheaper than new aluminum or scrap rolled material. In the case of unimportant castings of such section as are easy to cast, scrap aluminum is a desirable and economical material to use, and it can be run directly into castings after it is melted down. In some cases additional zinc can be added further to cheapen the alloy. This is not difficult provided the scrap comprises castings of similar sort, like gear casings, instead of being a heterogeneous mixture. In such a case the scrap will be of similar composition; and if a trial heat be made with zinc addition, there will be little difficulty in deciding the amount of zinc to be added to cheapen the mixture.

Scrap aluminum castings are easy to melt and recast, as the metal is broken with ease and easily charged into the crucibles. The only thing to be careful of is to keep the temperature below a cherry red between the intervals of charging new metal. When the crucible is as full as desired, a small piece of zinc chloride should be added and stirred into the metal to clear the surface. When the alloy contains much zinc, a little sal ammoniac has been found to do good, as this is the best flux to use in the case of zinc. For zinc aluminum chloride of zinc is the best flux.

PROPOSED ALUMINUM SPECIFICATIONS.

At the annual meeting of the American Society for Testing Materials the subcommittee on aluminum and aluminum alloys, Jesse L. Jones, Westinghouse Electric & Manufacturing Co., Pittsburgh, chairman, presented tentative specifications for aluminum for use in the manufacture of iron and steel. They cover two grades of virgin and four grades of secondary aluminum. Prof. William Campbell, Columbia University, reported also a complete revision of the tentative specifications for aluminum ingots for remelting and for rolling. Three grades are now proposed containing a minimum of 99.5, 99, and 98 per cent of aluminum. The new grade 99.5 per cent was added to meet the demands of the bureau of aircraft production and the manufacturers of electrical apparatus.

The proposed specifications are as follows:

TENTATIVE SPECIFICATIONS FOR ALUMINUM FOR USE IN THE MANUFACTUPE OF IRON AND STEEL. SERIAL DESIGNATION: B—20T.

These specifications cover the two grades of primary and four grades of secondary aluminum, as follows:

Primary aluminum.—Standard No. 2, containing not less than 98 per cent of aluminum. This grade is identical with standard No. 2 grade as given in Specification B–24—20T.

Standard No. 3, containing not less than 94 per cent of aluminum. The remainder is chiefly iron and silicon.

Secondary aluminum.—Remelted No. 1, containing not less than 98 per cent of aluminum. This grade is generally made from sheet clippings and the remainder may be chiefly copper, iron, and silicon.

Remelted No. 2, containing not less than 94 per cent of aluminum. A maximum of one-half of 1 per cent of zinc will be allowed in this grade. The remainder may be chiefly copper.

Remelted No. 3, containing not less than 90 per cent of aluminum. A maximum of one-half of 1 per cent of zinc will be allowed in this grade. The remainder may be chiefly copper.

Remelted No. 4, containing not less than 90 per cent of aluminum. A maximum of 4 per cent of zinc will be allowed in this grade. The remainder may be chiefly copper.

Manufacture.—The manufacturer shall use care to have each lot of metal as uniform as possible.

The aluminum may be in the form of ingots, rods, or shot.

Ingots should be convenient size for use. Three or five notch ingots weighing 1¼ to 1½ pounds will meet the requirements of this specification.

Rods may be either rolled or cast and ⅜ inch to ½ inch in diameter.

Shot should be of convenient size, that produced by running the molten metal through ⅛-inch diameter holes being satisfactory.

Sampling.—If the aluminum is shipped in carload lots, then random samples shall be taken—not more than five samples for each car. If the shipment is less than carload lots, one sample shall be taken for each 10,000 pounds (4,536 kilograms) or fraction thereof.

Samples shall be obtained by drilling completely through the ingot or half through from top to bottom. The weight of the sample obtained by drilling the ingot or ingots should not be less than 30 grams.

Rods shall be sampled in a similar manner, except that the drilling shall be radial.

An equivalent amount of shot shall be taken as a sample and reduced by quartering to a sample of convenient size.

Analysis.—Analyses shall be made in accordance with standard methods to be furnished by subcommittee VII on methods of analysis.

Identification.—The maker's brand on the grade of aluminum shall be cast or stamped on each ingot or rod and marked plainly on each container of shot metal.

Claims.—Claims, to be considered, shall be made in writing within 30 days of receipt of material at the purchaser's plant and the result of the purchaser's tests shall be given. The vendor shall, within one week of such claim, either agree to satisfy the claim or send a representative to the purchaser's plant to resample the shipment as specified in section 4. Samples as taken shall be sealed and submitted to a mutually agreeable umpire, whose determination shall be final.

The expense of umpire analysis shall be paid by the loser or divided in proportion to the concession made in case of a compromise. In case of rejection being established, the damage shall be limited to the payment of freight both ways by the vendor for the substitution of an equivalent weight of metal meeting these specifications.

TENTATIVE SPECIFICATION FOR ALUMINUM INGOTS FOR REMELTING AND FOR ROLLING. SERIAL DESIGNATION: B–24—20T.

These specifications cover these grades of primary aluminum, as follows:

Special, containing not less than 99.5 per cent of aluminum; standard No. 1, containing not less than 99 per cent of aluminum; standard No. 2, containing not less than 98 per cent of aluminum.

The presence of manganese, magnesium, zinc, or calcium in any of the above grades shall be regarded as evidence of the addition of more or less secondary aluminum.

Manufacture.—No scrap shall be used other than that resulting in the manufacturer's own plant from the production of material to this specification and which is of similar composition to the material specified.

Physical defects.—Ingots for rolling shall be of uniform quality, tough, and sound. They shall be substantially free from shrink holes, cold sets, pits, foreign matter, and other defects in set or casting. Such defects may be waived in ingots which are to be remelted.

Sampling.—If the aluminum is shipped in carload lots, then random samples shall be taken—not more than five samples for each car. If the shipment is in less than carload lots, one sample shall be taken for each 10,000 pounds (4,536 kilograms) or fractional part thereof.

Samples shall be obtained by drilling completely through the ingot or half through from top to bottom. The weight of the sample obtained by drilling the ingot or ingots should not be less than 30 grams.

Analysis.—Analyses shall be made in accordance with standard methods to be furnished by subcommittee VII on methods of analysis.

Identification.—The maker's brand or the grade of aluminum shall be cast or stamped on each ingot.

Claims.—Claims, to be considered, shall be made in writing within 30 days of receipt of material at the purchaser's plant and the results of the purchaser's tests shall be given. The vendor shall within one week of such claim, either agree to satisfy the claim or send a representative to the purchaser's plant to resample the shipment, as specified in section 3. Sample so taken shall be sealed and submitted to a mutually agreeable umpire whose determination shall be final.

The expense of umpire analysis shall be paid by the loser or divided in proportion to the concession made in case of a compromise. In case of rejection being established, the damage shall be limited to the payment of freight both ways by the vendor for the substitution of an equivalent weight of metal meeting these specifications.

SECONDARY NICKEL.

The reports received in 1918 showed that 1,393 tons of nickel was recovered in that year, a considerable part of which was obtained from clean new scrap. This did not include any nickel in scrap ferrous alloys nor the monel metal recovered from secondary sources made by the International Nickel Co. The monel scrap remelted by the International Nickel Co. was included with matte and ore, and no separate recovery was attempted. The reports received by the Survey for 1919 show that 2,447 short tons of nickel was recovered

from secondary sources, and this includes nickel in monel metal but not that in ferrous alloys. The quantity of nickel in matte, oxide, ore, etc., imported into the United States in 1919 was 36,562,388 pounds, or about one-half of the imports in 1918, most of which came from the Sudbury district, Ontario. The nickel-copper matte imported is partly refined and partly smelted to make monel metal. A considerable quantity of nickel was recovered at the refinery of the Missouri Cobalt Co., at Fredericktown, Mo., from ores which contain nickel, lead, copper, and cobalt. This production and the nickel content of nickel salts and metallic nickel obtained in the United States as a by-product in the electrolytic refining of copper amounted to 511 short tons in 1919.

Of the refined nickel produced, about 60 per cent is used in nickel steel, 30 per cent in white-metal alloys, 5 per cent in anodes for plating, and 5 per cent for miscellaneous purposes, including the manufacture of salts and other chemical compounds.

Secondary nickel recovered, 1919.

	Short tons.
Nickel recovered as metal	163
Nickel recovered in alloys and salts	2,284
	2,447
Nickel produced from ore mined in Missouri and as a by-product from the electrolytic refining of copper at domestic refineries	511
Nickel imported for consumption in the United States as nickel or in nickel ore and matte, oxide, and alloys	18,281

As nickel is used chiefly as an alloy in steel and as the secondary recoveries of nickel reported to the Geological Survey in 1919 were obtained solely from nonferrous scrap, it is evident that the 2,447 tons of nickel reported forms only a small portion of the nickel in alloys recovered and reused. The secondary nickel reported in 1919 was nearly all recovered from old nickel anodes, nichrome, nickel silver, and monel metal. A nickel alloy which is now being more generally used is composed of about 60 per cent nickel and the remainder mainly chromium. The properties and uses of this alloy called "nichrome" are described in the following extracts from an article recently published:[11]

Nichrome castings for heat treatment.—In heat-treating processes, such as annealing, carbonizing, hardening, and tempering, there is a demand for containers or receptacles made of metals or alloys, which will maintain their strength and durability at high temperatures. Such receptacles undergo repeated cooling and heating from 1,500° F. to 1,850° F., and in order to avoid costly maintenance due to additional expense for labor, fuel, material, and constant replacement, the heat-treating containers must not be subject to cracking, changing in form, forming a surface scale, or warping. Where the walls of annealing boxes, carbonizing boxes, etc., increase in thickness due to growing, or from a hard surface scale, relatively more time is required for the completion of the heat-treating process. In this case it takes longer for the heat to penetrate into the work. Where the physical strength of the material is comparatively small, it is necessary to increase the dimensions and weight of the receptacle to such an extent as to make handling difficult and to require considerable labor. The walls of heat-treating containers are preferably to be made as thin as possible in order to facilitate the greatest heat penetration.

Although many metals and alloys have almost any required physical properties at ordinary temperatures, still all undergo a reduction in strength, change of

[11] Equipment for foundry and plating room: Brass World, vol. 16, pp. 146–147, May, 1920.

form, or scaling of the exposed surface at high temperatures. There is a destructive reduction in the physical strength of cast iron, cast steel, structural steel, wrought iron, and other ferrous materials when subjected to relatively high temperatures. Although in one set of experiments structural steel at 400° F. showed an increase of 32 per cent of its normal strength at 70° F., and similarly wrought iron at 570° F. had 16 per cent greater strength than the normal strength at 70° F., nevertheless both of these materials had a tensile strength at 1,500° F., less than 18 per cent of their normal strength at 70° F. At 1,100° F. cast iron had lost 42 per cent of its normal at 70° F., and copper and bronze showed reduction in strength at as low a temperature as 200° F. The figures given would be, in general, subject to variation because of difference in the composition of materials of this class. Nevertheless, they are examples of the destructive effects mentioned above.

When cast iron is repeatedly heated to 1,700° F. it undergoes a change in size which is generally known as "growth," always accompanied by an increase in weight equivalent to approximately 7 or 8 per cent, which is due to the absorption of gases in the formation of oxide.

At high temperatures the oxidation of the heated metal causes a scale to be formed on the surface of cast-steel and wrought-iron containers, which usually reduces the size of the pot upon repeated heating, as in the case of annealing and case-hardening processes where the original scale cracks off, thereby exposing a fresh surface which again scales.

Properties of nichrome.—The injurious effects referred to may be avoided in many cases by the use of a nickel chromium alloy known as "nichrome." This alloy, made by the Driver-Harris Co., Harrison, N. J., is composed of about 60 per cent of nickel and the remainder principally chromium. It is melted in an electric furnace and is cast in various shapes and in any weight up to 5,000 pounds. Nichrome is already well known, since it has been used for some time in the manufacture of resistance coils and elements for electrical heating apparatus and rheostats. The surface of nichrome boxes and containers does not oxidize at high temperatures, except in oxidizing atmospheres, when a thin film of the oxide is formed which is extremely strong and durable. This oxide film resists the action of alkalies and of such acids as sulphuric and hydrochloric. It is nonflaking and affords additional protection against corrosion or further oxidation. Unlike iron or steel, nichrome shows no growth or appreciable change of form as a result of alternate heating and cooling. It will bend considerably before breaking, even when red or white hot. This quality may be demonstrated by heating to a red heat a plate of nichrome three-fourths inch thick and then striking it with a 20-pound sledge upon the unsupported center of the plate. The result is a very gradual bending. The tensile strength of cast nichrome at 1,500° F. is approximately 24,500 pounds per square inch, or about 30 per cent greater than the tensile strength of cast iron at 70° F. When cold, nichrome has a tensile strength of about 50,000 to 55,000 pounds per square inch. It softens at about 2,500° F., and melts at approximately 2,750° F.

For heat treatment cast nichrome is adapted for annealing and carbonizing boxes, heating retorts of various kinds, cyanide-hardening pots, lead-tempering pots, etc. Some of the most useful applications of this alloy will be mentioned to illustrate the possibilities of cast nichrome as a substitute for other materials in order to avoid crackling, growing, scaling, warping, change of form, corrosion, or reduction of strength.

Nichrome castings are used extensively for annealing and carbonizing boxes. They are much more durable than boxes made of cast steel. Whereas a steel box must be made quite thick in order to withstand reduction of thickness caused by scaling or oxidation, nichrome containers can be made thin and correspondingly light. Thus efficient heat conduction is insured at the same time maintaining sufficient strength. The durability of ferrous boxes is limited to approximately 250 hours' service at 1,700° F., whereas cast nichrome boxes under the same conditions quite commonly give 7,500 hours' service, and in some cases as many as 11,000 hours' service has been obtained.

While nichrome castings are more expensive than cast-steel or cast-iron containers, the difference in cost is more than offset by the superior qualities mentioned and by the low operating cost per hour which its use assures.

An important industrial application of cast nichrome is the dipping basket and holder used in immersing small heated iron or steel parts in a carbonizing cyanide bath at 1,700° F. Similar baskets or utensils are used for pickling purposes and heat-treating work. These nichrome baskets may be used for a considerable period of time without being appreciably affected by the cyanide

nor do they shrink or lose weight. They are about 100 times as durable as iron or steel wire baskets.

Rotary retorts of cast nichrome for gas-furnace applications are used in a great number of plants throughout the country with a life at temperature of 1,600° to 1,800° F. of from 18 months to 2 years, as against 20 days to 4 weeks with ferrous materials.

The fact that cast nichrome withstands high temperatures has enabled this material to be used for many important industrial purposes besides containers for heat-treating processes.

Analyses of various nickel alloys have already been published by the United States Geological Survey.[12]

[12] Hess, F. L., Nickel: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 763–765, 1917.

CHROMITE.

By J. S. Diller.

PRODUCTION AND CONSUMPTION.

Of the large quantity of chromite produced and on hand in the United States in 1918, 82,430 long tons was sold and 42,687 long tons was left unsold in the hands of the miners. After the armistice was declared in 1918 there was a great decline in prices, and production was reduced almost to its pre-war conditions.

The total domestic chromite of all grades shipped from mines in 1919 amounted to 5,079 long tons, valued at $129,302, or $25.46 a ton, a decrease of nearly 94 per cent in quantity and nearly 97 per cent in value from the shipments of 1918, although it exceeded the domestic output during any year before the war. There were 39 shippers altogether—1 in Wyoming, 2 in Maryland, 3 in Oregon, and 33 in California. Of the 5,079 long tons shipped in 1919, approximately 1,300 tons was mined in 1918. The difference, 3,779 long tons, does not, however, represent the actual quantity mined in 1919, as several producers reported small production but no shipments.

Crude chromite of all grades shipped from mines in the United States in 1918 and 1919.

[Quantity expressed in different units.]

		1918	1919
All grades	long tons	82,430	5,079
	short tons	92,322	5,688
	metric tons	83,749	5,160
All grades calculated on a basis of 50 per cent of chromic oxide	long tons	68,747	4,440
Content of metallic chromium	do	23,504	1,519

Apparent consumption of chromite in the United States in 1919.

	Quantity (long tons).	Value.	Average value per ton.
Sold during the year	5,079	$129,302	$25.46
Imported	61,404	1,381,497	22.50
Apparent consumption	66,483	1,510,799	.....

Crude chromite shipped from mines in the United States in 1919, by States.

State.	Number of shippers.	Ore containing 45 per cent or more of chromic oxide.		Ore containing 35 to 45 per cent of chromic oxide.		Ore containing 35 per cent or less of chromic oxide.		Total.	
		Quantity (long tons).	Average value per ton.	Quantity (long tons).	Average value per ton.	Quantity (long tons).	Average value per ton.	Quantity (long tons).	Value.
California	33	1,711	$28.87	1,360	$19.92	201	$19.79	3,272	$80,463
Maryland	2	54	55.42	4	56.25	11	22.64	69	3,467
Oregon	3	534	18.08	4	25.00	.....	.....	538	9,752
Wyoming	1	.....	.....	1,200	29.68	.....	.....	1,200	35,620
	39	2,299	26.99	2,568	24.54	212	19.93	5,079	129,302

Crude chromite shipped from mines in California in 1919, by counties.

County.	Number of shippers.	Ore containing 45 per cent or more of chromic oxide.		Ore containing 35 to 45 per cent of chromic oxide.		Ore containing 35 per cent or less of chromic oxide.		Total.	
		Quantity (long tons).	Average value per ton.	Quantity (long tons).	Average value per ton.	Quantity (long tons).	Average value per ton.	Quantity (long tons).	Value.
Alameda, Butte, Calaveras, Glenn	5	36	$22.61	126	$20.17	18	$27.61	180	$3,853
Eldorado	5	271	28.15	154	15.69	.....	.....	425	10,044
Napa, Trinity, Tuolumne	4	230	31.39	42	33.76	.....	.....	272	8,637
Nevada	3	27	20.00	.....	.....	170	19.24	197	3,810
Placer	4	355	30.57	.....	.....	.....	.....	355	10,851
San Luis Obispo	8	661	28.67	565	19.65	13	16.15	1,239	30,264
Siskiyou	5	131	25.95	473	20.30	.....	.....	604	13,004
	[a] 33	1,711	28.87	1,360	19.92	201	19.79	3,272	80,463

[a] Eliminating the duplication of one shipper who shipped from two counties.

California is still by far the leading producer of chromite in the United States. About 6 per cent of her output comes from the Klamath Mountains, but by far the greatest portion comes about equally from the Coast Range and the Sierra Nevada. The following is a list of those who reported shipments in California in 1919:

Young Adams & W. D. Hays, Middletown, Calif.
Arata & Dibblee, San Luis Obispo, Calif.
Arata & Lopez, San Luis Obispo, Calif.
Arata & Palmer, San Louis Obispo, Calif.
Lucille A. Bander, Grass Valley, Calif.
L. H. Butcher Co., 341 Montgomery Street, San Francisco, Calif.
California Chrome Co., Kohl Building, San Francisco, Calif.
P. S. Dean, Felix, Calif.
E. L. Elberg, San Luis Obispo, Calif.
Ferro-Alloy Co., 603 Symes Building, Denver, Colo.
H. L. Flournoy, Morro, Calif.
Geisendorfer & Turner, Weimer, Calif.
C. D. Hotchkiss, Georgetown, Calif.

William Johnson, 57 Bacon Building, Oakland, Calif.
J. V. Kappler, Etna Mills, Calif.
David L. McAfee, Valley Springs, Calif.
D. McDonald, Livermore, Calif.
C. S. Maltby, 1311 Humbolt Bank Building, San Francisco, Calif.
Morgan & Cramer, Fort Jones, Calif.
Placer Chrome Co., W. P. Netherton, manager, Santa Cruz, Calif.
Walter W. Pierce, Morro, Calif.
R. J. Pollock, Box 770, Grants Pass, Oreg.
A. J. Schmidt, 695 Walla Vista Avenue, Oakland, Calif.
Shaeffer Bros., R. D. No. 3, Grants Pass, Oreg.
William Shules, Hayfork, Calif.
H. B. Skewes, superintendent for A. A. Codd, Grass Valley, Calif.
Frank O. Smith, Forest Hill, Calif.
D. J. Sullivan, Dutch Flat, Calif.
G. E. Tarry, Aetna Springs, Calif.
Turnbull & Powell, Forest Hill, Calif.
Wachter & Hustler, Placerville, Calif.
Bulkeley Wells, 1213 Hobart Building, San Francisco, Calif.
Zenith Chrome Co., 424 Foxcroft Building, San Francisco, Calif.

Wyoming made the next largest shipments of chromite in 1919. The Ferro-Alloy Co., of Denver, was the only producer, and from its mine on Deer Crtek, Converse County, Wyo., it shipped chromite to its own works at Pueblo, Colo. The output from Wyoming was far greater in 1919 than in 1918.

In Oregon three producers reported from Josephine County, only one of which, however, reported shipments. The two producers of high-grade chromite near Prairie City, Gant County, F. W. Peet andr Peter Delore, shipped nearly all the ore they produced.

Two companies produced in Maryland, the Maryland Chrome Co. and the Chrome Mining Co., both of Baltimore and both operating in that vicinity.

Chromite of all grades shipped from mines in the United States, 1910–1919.

Year.	Quantity (long tons).	Value.	Average value per ton.	Year.	Quantity (long tons).	Value.	Average value per ton.
1910	265	$2,729	$13.31	1915	3,281	$36,744	$11.20
1911	120	1,629	13.58	1916	47,035	726,243	15.44
1912	201	2,753	13.70	1917	43,725	1,049,400	24.00
1913	255	2,854	11.19	1918	82,430	3,955,567	47.99
1914	591	8,715	14.75	1919	5,079	129,302	25.46

IMPORTS.

The total imports of chromite dropped from 100,142 long tons in 1918 to 61,404 long tons in 1919, a decline of nearly 39 per cent following the cessation of the demand for chromite for war purposes. The imports of 40 per cent ore from Cuba nearly doubled in 1919, and Cuba has become the principal source of imported chromite. The imports of high-grade ore from Australia and Guatemala changed but little from 1918, but the imports of chromite from Canada, Brazil, and French Oceania decreased greatly. This decrease was partly made up by imports from new countries—New Zealand, Spain, and Turkey in Asia.

Crude chromite imported into the United States, 1913–1919, in long tons.[a]

Country.	1913	1914	1915	1916	1917	1918	1919	Grade of ore imported (per cent of chromic oxide).	Average value per ton in country of origin.
Australia				[b] 2,986		15,976	13,161	55	$39.76
Brazil						17,854	4,800	45	45.48
British South Africa			22,800	[c] 23,000	4,750	521	29	50	173.00
Canada		533	10,087	12,220	19,012	20,949	8,941	30	22.14
Cuba				34	17	8,821	14,461	40	9.43
England		58	2	5	5	4		50	
French Oceania	21,850	30,860	28,031	[b] 30,950	10,300	25,761	7,125	55	9.48
Greece	4,600	8,155	4,305	7,900					
Guatemala					179	1,193	1,659	58	56.88
Japan	79								
New Zealand							693		12.17
Other British Oceania						1,063		55	
Portuguese Africa	30,001	23,200	11,230	[c] 38,850	37,800	8,000	4,000	50	4.82
Spain							3,035		16.89
Turkey in Asia	8,650	11,880					3,500		17.00
	65,180	74,686	76,455	115,945	72,063	100,142	61,404		

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.
[b] E. J. Lavino & Co., importers, credit New Caledonia with all ore listed under French Oceania and Australia, amounting to 33,936 long tons.
[c] E. J. Lavino & Co., importers, credit Rhodesia with all ore listed under British South Africa and Portuguese Africa, amounting to 61,850 long tons.

Chromium compounds imported for consumption in the United States, 1917-1919.[a]

		1917			1918			1919		
		Quantity.	Value.	Value per unit.	Quantity.	Value.	Value per unit.	Quantity.	Value.	Value per unit.
Chromic iron ore	long tons	72,063	$1,110,659	$15.41	100,142	$2,892,825	$28.88	61,404	$1,381,497	$22.50
Chromic acid	pounds				9,512	1,857	.19			
Chromate and bichromate of potash	do	2,402	962	.40	20	8	.40	15,450	4,271	.28
Chrome or chromium and ferrochromium	long tons							414	100,404	242.52
Chromate and bichromate of soda	pounds	22,025	4,075	.19	5,102	1,184	.23			

[a] Statistics compiled from records of Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

PRICES.

No great changes took place in prices of chromite in 1919. The table showing the output of California (p. 88) gives the average value of the several grades sold at the railroad shipping points, and in the tables of imports (p. 89) are given the average values of the several grades in the countries from which they came. There is no available explanation of the great differences in prices in these countries. The selling prices of chromite in the New York market are based chiefly on the richness of the ore, which determines its value for manufacture. According to the Engineering and Mining Journal, November 20, 1920, guaranteed 50 per cent foreign ore with a maximum of 6 per cent of silica was quoted at 80 to 85 cents a unit, New York City. California concentrates carrying 50 per cent or more of chromic oxide were quoted at 70 and 75 cents a unit f. o. b. mines.

MANGANESE AND MANGANIFEROUS ORES.[1]

By H. A. C. Jenison.

GENERAL CONDITIONS.

The great industrial reaction that followed the World War was immediately transmitted through the steel industry to the dependent manganese industry with disastrous effects. The condition of the steel industry, the expected renewal of importation of manganese that would be permitted by the increasing number of ships available for commercial use, and the fact that large stocks of manganese were being held by the steel producers and brokers reacted so severely upon the domestic manganese industry that it began to disintegrate rapidly, as shown by the abrupt decrease in shipments of manganese ore in November, 1918. As fast as war contracts expired the operators were confronted by low prices, decreasing demand, and inability to renew the contracts. In the summer of 1919 nearly all the war contracts expired and the collapse of the domestic industry was complete.

Doubtless many of the deposits that had been developed were of such a nature that they could never have been operated at a profit. Many operators had developed low-grade deposits that could not have competed with foreign deposits before the war, and nearly all of them had made great expenditures in developing deposits before production could be begun. At many mines production had barely begun when the rapid reaction set in that made it impossible for many operators to sell enough ore to cover their initial expenditures. Many who suffered in this way were compensated through the war minerals relief act; but this act as interpreted at present is of insufficient scope to relieve all those who incurred losses.

RESERVES IN THE UNITED STATES.

The history of the manganese industry before, during, and since the war makes desirable a comparison of the distribution, extent, character, and grade of the manganese deposits of the United States with those of the deposits in the rest of the world. The manganese deposits of the United States are by this time so well known that a description of them here is unnecessary. (See bibliography, pp. 141–148.) However, the length of time during which they could supply the American steel industry is a matter of great importance. The following table, taken from a paper by Harder and Hewett,[2] represents the most complete and reliable data that have been compiled upon the reserves of manganese ore in the United States:

[1] The statistical tables in this report were prepared by Miss Helena M. Meyer, and the data on imports and exports were compiled from records of the Bureau of Foreign and Domestic Commerce by J. A. Dorsey, both of the United States Geological Survey.

[2] Harder, E. C., and Hewett, D. F., Recent studies of domestic manganese deposits: Am. Inst. Min. and Met. Eng. Trans., September, 1919.

Reserves of manganese and manganiferous ores in the United States, December, 1918.

State or district.	Authority.	Number of deposits examined. 1916–1918.	Work concluded.	Number of deposits examined less than 50 tons.	Manganese 35+ per cent.			Manganese 5–35 per cent, largely more than 20 per cent of silica, less than 30 per cent of iron.			Manganese 5–35 per cent, largely more than 30 per cent of iron and less than 20 per cent of silica.			Remarks.
					Number of deposits.	Reserves (tons).	Additional reserve in prospect (tons).	Number of deposits.	Reserves (tons).	Additional reserve in prospect.	Number of deposits.	Reserves (tons).	Additional reserve in prospect.	
Arizona	F. L. Ransome, E. L. Jones, jr.	76	Mar., June, 1918.	12	40	82,000	(?)	23	235,000	(?)	1	5,000	.....	Practically all recorded deposits have been examined.
Arkansas, western	H. D. Miser	37	June, 1916	30	5	600	.....	2	200	.....	.....	.....	.....	Do.
Arkansas, Batesville district.	do	181	June, 1918	26	110	100,000	160,000	45	160,000	(?)	.....	.....	.....	Do.
California	G. D. Louderback and associates.	a 202	Sept., 1918.	97	59	45,000	(?)	43	54,000	(?)	3	6,000	.....	Practically all recorded deposits have been examined in cooperation with California Council of Defense.
Colorado, Leadville district.	J. B. Umpleby	13	Aug., 1917.	.....	.....	.....	.....	.....	.....	.....	13	700,000	800,000	Most important deposits examined; material commonly ranges from 20 to 30 per cent of iron.
Colorado, other districts.	J. B. Umpleby, E. L. Jones, jr.	5	July, 1917..	4	2	1,000	.....	1	200	.....	2	750,000	250,000	Only a few deposits in Chaffee, Eagle, Fremont, and San Miguel counties examined.
Georgia	J. P. D. Hull, F. C. Schrader.	53	July, 1918..	1	25	100,000	200,000	17	50,000	230,000	.....	.....	.....	All deposits in Bartow, several in Fannin, Murray, and Polk counties examined in cooperation with Georgia Geological Survey.
Minnesota, Cuyuna range.	J. F. Murphy	10	1917	.....	.....	.....	.....	.....	.....	.....	10	2,254,000	(?)	Cuyuna range, less than 0.125 per cent of phosphorus.
Do	do	15	1917	.....	.....	.....	.....	.....	.....	.....	15	11,374,000	(?)	Cuyuna range, more than 0.125 per cent of phosphorus.
Montana, Butte district.	J. T. Pardee	62	Aug., 1917.	.....	2	2,800	.....	60	400,000	.....	.....	.....	.....	All recorded deposits of oxide ores examined; estimate does not include large deposits of carbonate ore, 35 to 38 per cent of manganese.
Montana, Philipsburg district.	do	25	Oct., 1918.	.....	25	130,000	350,000	19	56,000	230,000	.....	.....	.....	

Montana, other districts.	J. T. Pardee	4	1917	1	1	100		2	700		1	1,800		Madison County.
Nevada	J. T. Pardee, J. C. Jones, E. L. Jones, jr.	35	July, 1918.	2	18	21,000	(?)	15	6,000		4	552,000	500,000	All recorded deposits have been examined.
New Mexico	E. L. Jones, jr., J. B. Umpleby, E. H. Wells.	22	....do.....	6	7	3,500		6	133,000		3	500,000	500,000	Do.
North Carolina	F. C. Schrader	17	Nov., 1918.	14	1	50		2	200					Almost all recorded deposits have been examined.
Oklahoma	D. F. Hewett	3	Oct., 1917.		3	1,000		2	1,700					Johnson County only; examined in cooperation with Oklahoma Geological Survey.
Oregon	J. T. Pardee, E. S. Larsen.	23	Aug., 1918.	15	6	13,000		2	101,000					All recorded deposits in Baker, Jackson, and Josephine counties have been examined.
Tennessee	G. W. Stose, F. C. Schrader.	120	Oct., 1918.	78	42	45,000	20,000		25,000	20,000	15	10,000		All recorded deposits have been examined in cooperation with Tennessee Geological Survey.
Utah	V. C. Heikes, J. T. Pardee.	45	June, 1918.	25	15	11,000	(?)	5	4,000					All recorded deposits have been examined.
Virginia, east side of valley.	G. W. Stose, H. D. Miser, F. J. Katz, D. F. Hewett.	110	Sept., 1917.	58	30	100,000	350,000				22	5,000	100,000	All recorded deposits have been examined except in Piedmont region, east of Blue Ridge.
Virginia, west side of valley.	G. W. Stose, H. D. Miser.	84	Sept., 1918.	45	25	42,000	50,000				14		(?)	Examined in cooperation with Virginia Geological Survey.
Washington	J. T. Pardee	32	Aug., 1918.	2	1	500		30	86,000	(?)				All recorded deposits except several in Grays Harbor County examined; reserves range from 30 to 35 per cent of manganese.
Alabama	G. W. Stose	7	1917 and 1918.	2	4	1,200		1	10,000	(?)				Some important deposits not examined.
Idaho	L. G. Westgate													
South Carolina	F. C. Schrader													
Texas	J. B. Umpleby													
Wyoming	E. L. Jones, jr.													
		1,181		428	421	699,750	1,130,000	275	1,323,000	480,000	103	16,157,800	2,150,000	

[a] Incomplete.

NOTE.—The interrogation mark indicates that further exploration will probably reveal additional reserves.

CLASSIFICATION OF RESERVES.[3]

The classification in the preceding table indicates as far as possible the use to which the ore may be put. Ore containing 35 per cent or more of manganese may contain as much as 40 per cent of silica, thus being unacceptable for the manufacture of ferromanganese; but the largest part of the material so classified is suitable for the manufacture of ferromanganese containing 70 to 80 per cent of manganese, and by careful mixing virtually all the ore of this class can be so utilized. In the calculation of reserves in those deposits that are not homogeneous throughout only the part containing 35 per cent or more of manganese was considered. The average manganese content of this first class of ore is about 40 per cent.

The second class represents ore containing from 5 to 35 per cent of manganese and usually less than 30 per cent of iron. Such ore is not readily utilized because of its high content of silica or lime. The average manganese content is about 25 per cent. With some improvements now in process this ore would become an available source of manganese.

The third class represents the ore in which the manganese content is equal to or less than the iron content. Such ore is suitable for the manufacture of spiegeleisen unless the content of phosphorus is too great, in which case it may be used for the manufacture of high-manganese pig iron. The average manganese content of the ore is about 16 per cent.

High-grade ore.—The greatest, best developed, and most available domestic reserves of high-grade ore are in the Philipsburg district of Montana. Other great reserves of high-grade ore undoubtedly exist in Arkansas, Georgia, Tennessee, and Virginia, but they are only partly developed and require very elaborate milling equipment. The reserves of high-grade ore in Arizona are of considerable size, but they contain less manganese and more silica than the other reserves. About 850,000 gross tons of high-grade ore was required in the production of 44,000,000 tons of steel in 1918, and at that rate the high-grade reserves could supply the requirements of the steel industry for less than two years.

Low-grade ore.—The greatest reserves of low-grade siliceous ore occur in Arizona and in the Butte district of Montana, but only a small part of their ore could be successfully concentrated even during the period of high prices. Only under very high prices that were assured for a considerable length of time and that would justify enough research to develop a suitable process of concentration could these ores be considered workable reserves. There are in Washington other deposits of siliceous manganese ore which on account of the possibility of hydroelectric smelting there would under the same circumstances also add somewhat to the reserves.

Three-fourths of the reserves of low-grade ferruginous manganese ores appear to be in the Cuyuna range, Minnesota. Although many problems have been encountered in marketing these ores, they must be considered the most valuable source of manganese ore in the country.

[3] Harder, E. C., and Hewett, D. F., op. cit.

Other deposits of a similar nature occur at Leadville, Colo., and at Silver City, N. Mex., but though their manganese content is higher, their location is a decided disadvantage. The ore reserves of the Pioche district, in Nevada, are considerable, but their market depends on very high prices. The low-grade ores must be considered the most important domestic source of manganese, but their utilization depends very largely on the increased use of spiegeleisen or on new processes of making steel.

As a result of high prices and great necessity the entire country has been carefully examined for manganese deposits, and, though it would be unwise to assume that further exploration may not reveal many additional deposits, it appears certain that by far the largest part of the reserves of the country are known.

Among other results of high prices and war demands was the increase in production from about 2 per cent of the country's needs in 1916 to about 35 per cent in 1918, and the really important discovery that the problems of utilization were not insuperable, as was previously supposed. From this it is safe to assume that the steel and related industries could maintain the rate of their consumption of manganese in 1918 from domestic sources alone for a short time.

If the great metallurgic problems involved in the utilization of the low-grade ore in place of high-grade ore are overcome, the manganese reserves would of course be greatly increased. However, the low-grade deposits could, under great need, approximately double the life of the supply from the high-grade deposits.

FOREIGN RESERVES.

It is not practicable at this time to make an exhaustive statement regarding the extent of foreign manganese reserves, but sufficient data are at hand to prove that they are vastly greater than the American reserves. In contrast to the 21,940,550 gross tons of domestic ore of all grades in reserve, the Tchiatouri deposits, south of the Russian Caucasus, are estimated to contain alone from 45,000,000[4] to 110,000,000[5] tons of ore containing as shipped 50 per cent of manganese, 6 to 8 per cent of silica, 1 per cent of iron, and 0.05 to 0.17 per cent of phosphorus, or enough to supply the high-grade manganese requirements of the American steel industry at the rate of production in 1918 for a minimum of 50 years. The deposits at Nikopol and in the Ural Mountains are not so great as those mentioned, but they too contain great reserves. Brazil, India, and Chile likewise contain very large reserves of high-grade ore. Brief descriptions of the more important manganese deposits in these and other foreign countries are given on pages 114–141.

The high-grade deposits of Russia, India, and Brazil are for the most part easily and cheaply mined, and under normal conditions, competition with them from deposits in other countries is difficult.

[4] Eng. and Min. Jour., May 15, 1920.
[5] Beyschlag, F., Krusch, P., and Vogt, J. H. L., Lagerstätten der nutzbaren Mineralien und Gesteine, Band 2, p. 592.

SUMMARY OF STATISTICS.

Manganese alloys and ore produced in the United States and imported from important foreign sources, 1910–1919, in gross tons.

Year.	Steel.	Ferromanganese.		Spiegeleisen.		Manganese ore.				
	Production.[a]	Shipments.	Imports.	Shipments.	Imports.	Shipments.	Total imports.	Imports from—		
								Russia.	India.	Brazil.
1910	26,094,919	[b] 71,376	114,228	[b]153,055	25,383	2,258	242,348	33,120	140,965	53,750
1911	23,676,106	74,602	80,263	104,013	20,970	2,457	176,852	19,103	103,580	41,600
1912	31,251,303	125,378	99,137	102,561	1,015	1,664	300,661	83,334	128,645	81,580
1913	31,300,874	119,495	128,070	106,980	77	4,048	345,090	124,337	141,587	70,200
1914	23,513,030	100,731	82,997	76,625	2,870	2,635	283,294	52,681	103,583	113,924
1915	32,151,036	144,260	55,263	114,556	200	9,613	320,778	.....	36,450	275,579
1916	42,773,680	224,103	90,928	182,837	.....	31,474	576,321	.....	51,960	471,837
1917	45,060,607	260,225	41,969	189,241	3,968	129,405	629,972	.....	48,975	512,517
1918	44,462,432	306,076	27,168	263,861	1,969	305,869	491,303	.....	29,275	345,877
1919	34,671,232	[b] 185,357	33,022	[b] 84,246	27	55,322	333,344	6,916	9,200	246,592

[a] According to American Iron and Steel Institute.
[b] Figures of production, according to American Iron and Steel Institute. Figures of shipments not available.

SOURCES OF MANGANESE.

MANGANESE MINERALS.

Though manganese forms a part of about 100 minerals and is a relatively widespread element, practically all the manganese in commercial use is derived from material containing one or more of the first seven of the minerals named in the following table:

Principal manganese minerals.

Mineral.	Composition.	Percentage of manganese.
Polianite	MnO_2	63.2
Pyrolusite	$MnO_2.nH_2O$	60–63
Psilomelane	$MnO_2.(Mn,K,Ba)O.nH_2O$	45–60
Wad	Hydrous impure mixture of manganese oxides	5–50
Manganite	$Mn_2O_3.H_2O$	62.4
Braunite	$3\,Mn_2O_3.MnO.SiO_2$	69
Franklinite	$(Fe,Zn,Mn)O.(Fe,Mn)_2O_3$	10–19
Rhodochrosite	$MnO.CO_2$	47.56
Rhodonite (manganese pyroxene)	$MnO.SiO_2$	41.9
Tephroite (manganese olivine)	$2MnO.SiO_2$	54.3
Spessartite (manganese garnet)	$3\,MnO.Al_2O_3.3SiO_2$	33.3

MANGANESE ORES.

In the report on manganese ores in 1916,[6] a new classification of the manganese-bearing raw materials of the United States was adopted. It was the purpose of the new classification to group the raw materials according to manganese content so that the quantities of material capable of certain specific uses would be indicated. Thus, in restricting the term "manganese ore" to materials con-

[6] Hewett, D. F., U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 733–734, 1919.

taining more than 40 per cent of manganese it was the intention to indicate that practically all material in this class was capable of being smelted to ferromanganese containing 80 per cent of manganese, the product which is made from a large part of such ore. The war brought about changes in practice in the making and use of manganese alloys, so that early in 1918 it seemed desirable to change the limits previously placed in the classification of the ores. The action that led to this change was the recommendation in April, 1918, by the American Iron and Steel Institute to its members, who include the officials of practically every steel company in the United States, that ferromanganese with 70 per cent of manganese be used as far as practicable in place of the 80 per cent alloy, and that spiegeleisen with 16 per cent of manganese be used in place of the 20 per cent alloy, and, therefore, that alloys of the lower grades be accepted on contracts for the higher grades. The purpose of lowering the grade of ferromanganese from 80 to 70 per cent of manganese was to permit the wider use of domestic ores in making the alloy. Actually the grade of alloy which may be made from an ore depends largely upon the percentages of manganese, iron, and silica that are present. If a classification were to indicate truly the use to which the material could be put it should properly be based upon assigned limits to each of these ingredients. In the United States, however, there are few large deposits of manganiferous materials of any grade which appear to be capable of shipping regularly over long periods material which shows the narrow ranges in composition that much foreign material shows. The actual work required in a classification of the shipments from individual mines according to a system based upon the percentages of manganese, iron, and silica, is too great to permit its ready adoption by the industry. In spite of certain obvious objections, therefore, the adopted classification is based upon the manganese content alone.

The new classification aims to group materials that are capable of being used to make the grades of alloys adopted as a war expedient. It remains to be determined whether the steel industry will continue to make and use the new grades of alloys, or whether, when the supply of high-grade foreign ores is not hindered, the industry will demand the old grades. Probably many steel makers will return to the use of the old grades of alloys, but as some makers appear to be satisfied with the new grades it will serve a purpose to continue the classification of ore adopted during the war.

Materials with more than 35 per cent of manganese will be considered manganese ore. If the manganese in such materials is present as one of the common oxides, it is possible for other substances to make up about 45 per cent of the total. On the other hand, if the manganese is present as carbonate, only 27 per cent of other substances may be present. During 1917 large quantities of oxide material were marketed from Arizona, California, and Montana, which contained more than 16 per cent of silica, and some mines report shipments containing as much as 27 per cent of silica. The iron content of manganese ores from most of the States is low—generally from 2 to 5 per cent—but material from several districts, especially Bisbee, Ariz., and Lake Valley, N. Mex., ranges from 3 to 11 per cent and the average is close to 9 per cent. The average composition

of the entire production during 1917—129,405 tons—as reported by the shippers, was manganese, about 42.5 per cent; iron, 2.8 per cent; silica, 14 per cent; natural basis, but moisture not reported.

Materials containing 10 to 35 per cent of manganese will be considered ferruginous manganese ore. In the report for 1916 the range for material under this class was 15 to 40 per cent of manganese. It should be stated that there is no natural basis for choosing the percentage that marks the dividing line between manganese ore and ferruginous manganese ore. Any such percentage must be arbitrarily chosen on the basis of the use to which the material is to be put. It is worthy of notice that although large quantities of both oxide and carbonate materials containing from 35 to 40 per cent of manganese were shipped from a number of States during 1917, relatively little material containing 25 to 35 per cent of manganese has been produced from domestic deposits. Most of the material that is classified as a ferruginous manganese ore, produced largely in Minnesota, Michigan, Nevada, and Colorado, contains from 14 to 25 per cent of manganese, from 25 to 35 per cent of iron, and from 8 to 20 per cent of silica.

The objection has been made that in some districts such material has long been known as manganiferous iron ore and that it will be confusing to restrict the name to material with 5 to 10 per cent of manganese, which was not widely mined and used until recently, and to apply a new name to material that was formerly known by the old name. In reply to this objection it may be stated that there is need for two terms and that the material containing more than 10 per cent of manganese is of greater interest and commonly derives more value from its manganese than from its iron content. Spiegeleisen, containing 16 per cent of manganese, may be made from most of the material that is produced in the United States at present, although less than one-third was so used in 1917.

Material containing 5 to 10 per cent of manganese is classified as manganiferous iron ore. The market for such material lies mainly with the makers of basic pig iron, so called because it is especially adapted to make steel by the basic open-hearth process. There is no record that any of this material is used for making spiegeleisen.

The term "manganiferous silver ore" is applied to those materials, either oxides or carbonates, that contain more than 5 per cent of manganese and sufficient silver to make them more valuable as a source of silver than of manganese. Such materials commonly contain from 5 to 45 per cent of iron, several per cent of silica and lead, and a little gold and copper and are shipped to lead or copper smelters, where the silver, gold, lead, and copper are recovered and the manganese aids in making a more fusible and fluid slag.

Manganiferous zinc residuum is a product that commonly contains 12 to 15 per cent of manganese and is obtained by roasting franklinite, a mineral found only in several deposits near Franklin Furnace, N. J.

MANGANESE AND MANGANIFEROUS ORES.

SHIPMENTS.

Manganese and manganiferous ore shipped in 1918.

State.	Ore containing 35 per cent of manganese or more.			Ore containing 10 to 35 per cent of manganese.			Ore containing 5 to 10 per cent of manganese.		
	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.
Alabama	1	709	(a)	4	443	$8,424			
Arizona:									
Used for fluxing				2	4,772	(a)	1	6,082	(a)
Used for other purposes	35	17,612	$570,005	8	1,986	25,022			
Arkansas	21	7,731	354,235	19	9,173	93,525			
California	47	24,067	740,566	2	68	(a)			
Colorado:									
Used for fluxing				b 18	13,217	19,826	22	c 11,714	$17,571
Used for other purposes	4	4,821	180,246	b 14	99,137	548,714			
Georgia	12	6,679	284,615	11	9,510	56,983	2	1,266	(a)
Michigan				1	22,673	(a)			
Minnesota				13	630,827	3,295,090	6	229,869	947,767
Montana	37	199,932	4,623,378						
Nevada:									
Used for fluxing				2	80,096	(a)			
Used for other purposes	17	19,872	544,727	4	258	2,737			
New Jersey	1	64	(a)						
New Mexico:									
Used for fluxing				1	75	(a)	1	400	(a)
Used for other purposes	12	3,126	80,195	5	32,832	159,140			
North Carolina	1	315	(a)	1	30	(a)			
Oregon	1	198	(a)						
South Carolina	1	100	(a)	1	850	(a)			
South Dakota	1	31	(a)						
Tennessee	23	4,162	153,830	11	2,307	43,368	1	51	(a)
Texas	1	380	(a)						
Utah	10	5,100	140,038						
Virginia	21	10,928	500,528	15	7,859	103,058	2	4,917	(a)
Wisconsin							d 1	d 215,839	(a d)
Wyoming	1	42	(a)	1	50	(a)			
Undistributed			68,023			247,903			696,701
	247	305,869	8,240,386	b 126	916,163	4,603,790	d 35	cd 254,299	d 1,031,789

a Included under "Undistributed," Geological Survey not at liberty to publish.
b Seven shippers of flux in Colorado are also shippers of ores for other purposes in Colorado. These shippers do not duplicate in the total for the United States.
c Includes 1,684 gross tons of ore containing less than 5 per cent of manganese.
d Manganiferous iron ore from Wisconsin, containing approximately 5 per cent of manganese, not included in totals for United States.

Manganese and manganiferous ore shipped in 1919.

State	Ore containing 35 per cent of manganese or more.			Ore containing 10 to 35 per cent of manganese.			Ore containing 5 to 10 per cent of manganese.		
	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.	Number of shippers.	Quantity (gross tons).	Value.
Alabama	1	40	(a)	.....	.....	.....	.....	.....	.....
Arizona:									
Used for fluxing	1	18	(a)	1	1,964	(a)	.....	.....	.....
Used for other purposes	4	529	$14,445	.....	.....	.....	.....	.....	.....
Arkansas	5	2,558	60,633	2	564	(a)	.....	.....	.....
California	9	11,289	329,200	.....	.....	.....	.....	.....	.....
Colorado:									
Used for fluxing	.....	.....	.....	b 16	18,423	$27,635	9	c 11,346	$17,019
Used for other purposes	3	11,166	238,671	b 5	11,071	121,421	.....	.....	.....
Georgia	1	48	(a)	1	3,496	(a)	2	230	(a)
Michigan	.....	.....	.....	1	29,296	(a)	.....	.....	.....
Minnesota	.....	.....	.....	8	138,952	546,685	3	106,931	339,311
Montana	6	24,993	993,633	.....	.....	.....	.....	.....	.....
Nevada:									
Used for fluxing	1	347	(a)	2	77,815	(a)	.....	.....	.....
Used for other purposes	1	78	(a)	1	6,225	(a)	1	1,070	(a)
New Mexico	.....	.....	.....	2	12,198	(a)	4	4,322	5,448
North Carolina	.....	.....	.....	1	30	(a)	.....	.....	.....
Tennessee	6	328	8,388	1	35	(a)	.....	.....	.....
Virginia	6	3,928	142,431	2	9,765	(a)	.....	.....	.....
Wisconsin	.....	.....	.....	.....	.....	.....	d 1	d 115,983	(a d)
Undistributed	.....	.....	9,462	.....	.....	486,787	.....	.....	324,990
	44	55,322	1,796,863	b 41	309,834	1,182,528	d 19	c d 123,899	d 369,964

a Included under "Undistributed." Geological Survey not at liberty to publish.
b Two shippers of flux in Colorado are also shippers of ore for other purposes in Colorado. These shippers do not duplicate in the total for the United States.
c Includes 844 gross tons of ore containing less than 5 per cent of manganese.
d Manganiferous iron ore from Wisconsin, containing approximately 5 per cent of manganese, not included in totals for the United States.

Manganese and manganiferous ore shipped from mines in the United States, 1910 to 1919, in gross tons.

Year.	Ore containing 35 per cent of manganese or more.	Ore containing 10 to 35 per cent of manganese.	Ore containing 5 to 10 per cent of manganese.
1910	2,258	41,260	19,841
1911	2,457	37,584	6,853
1912	1,664	40,863	10,654
1913	4,048	51,512	7,891
1914	2,635	91,666	6,599
1915	9,613	180,953	a 14,782
1916	31,474	453,853	b 90,473
1917	129,405	730,759	c 130,185
1918	305,869	916,163	d 254,299
1919	55,322	309,834	e 123,899

a Includes 796 tons of ore containing less than 5 per cent of manganese.
b Includes 1,026 tons of ore containing less than 5 per cent of manganese.
c Includes 141 tons of ore containing less than 5 per cent of manganese.
d Includes 1,684 tons of ore containing less than 5 per cent of manganese.
e Includes 844 tons of ore containing less than 5 per cent of manganese.

MANGANESE ORE.

SHIPMENTS.

The shipments of manganese ore in 1919 amounted to 55,322 gross tons, valued at $1,796,863, a decrease of 250,547 tons in quantity and of $6,443,523 in value from 1918. In 1919 there were 44 shippers of material containing 35 per cent or more of manganese, compared with 247 in 1918; 41 shippers of material containing 10 to 35 per cent of manganese, compared with 126 in 1918; and 19 shippers of material containing 5 to 10 per cent of manganese, compared with 35 in 1918.

IMPORTS.

The following table was compiled from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce:

Manganese ore imported into the United States, 1916–1919.

Country.	1916		1917		1918		1919	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Africa			4	$180	95	$2,128	1,338	$19,157
Argentina			6,600	40,023	849	39,127	2,305	86,547
Australia	488	$19,313			198	13,990	548	26,365
Brazil	471,837	7,139,821	512,517	8,578,296	345,877	10,174,138	246,592	7,177,071
British India	51,960	401,779	48,975	362,582	29,275	547,886	9,200	254,971
Canada	756	72,496	883	40,534	301	11,968	582	16,926
Chile		18	202	6,330	2,998	48,760	441	13,950
China			20	438	3,000	146,909	1	30
Colombia							10	969
Costa Rica	1,244	38,703	7,163	211,601	9,680	290,853	9,988	351,237
Cuba	30,563	514,184	44,511	612,413	82,974	2,751,193	35,320	1,433,202
Ecuador					107	3,422	20	641
Germany		16						
Greece	3,000	24,318						
Hongkong							1,265	27,940
Japan	5,196	163,491	2,745	85,538	709	30,337	651	39,039
Mexico	390	7,093	345	9,790	5,251	159,357	6,295	266,307
Panama	10,498	265,772	5,202	163,120	5,607	262,520	2	76
Peru					20	641		
Portugal	289	11,997					400	31,100
Russia							6,916	296,915
Turkey							2,000	120,000
United Kingdom	100	7,178	805	152,084	4,362	612,638	9,470	1,066,741
	576,321	8,666,179	629,972	10,262,929	491,303	15,095,867	333,344	11,229,184

PRODUCTION IN PRINCIPAL PRODUCING COUNTRIES.

Manganese ore produced in principal producing countries, 1913 to 1919, in metric tons.

Country.	Percentage of manganese.	1913	1914	1915	1916	1917	1918	1919
North America:								
Canada	.....	.....	25	182	868	143	399	[a] 591
Costa Rica	37–48	.....	.....	.....	[a] 1,263	[a] 7,278	[a] 9,835	[a] 10,148
Cuba	36–44	.....	.....	[a] 5,223	[a] 31,054	[a] 45,225	[a] 81,306	[a] 35,887
Mexico	40+	.....	.....	.....	.....	73	2,878	[b] 114
Panama	50±	.....	.....	.....	[a] 10,666	[a] 5,285	[a] 5,696	[a] 2
Porto Rico	35+	.....	.....	.....	[c] 749	[c] 1,208	[c] 1,372	[d]
United States	35+	4,113	2,677	9,767	31,978	131,482	310,778	56,210
South America:								
Brazil	38–50	122,300	183,630	288,671	503,130	532,855	[a] 351,428	[a] 250,559
Chile	40–48	.....	.....	.....	.....	[a] 205	[a] 3,046	[a] 448
Ecuador	.....	.....	.....	.....	.....	.....	[a] 109	[a] 20
Peru	.....	.....	.....	.....	.....	.....	[a] 20	.....
Europe:								
Austria	.....	16,540	13,808	11,926	[d]	[d]	[d]	[d]
Belgium	.....	.....	.....	500	3,870	2,040	2,610	.....
Bosnia and Herzegovina	.....	5,800	[d]	10,422	22,674	48,851	[d]	[d]
France	30+	7,732	6,393	10,324	10,807	11,589	9,871	4,815
Germany	30+	760	[d]	[d]	[d]	[d]	[d]	[d]
Greece	.....	.....	.....	408	3,600	.....	[d]	[d]
Hungary	.....	19,006	14,413	[d]	[d]	90,269	[d]	[d]
Italy	18–45	1,622	1,649	12,577	18,147	24,532	31,896	30,841
Russia	41–48	1,310,064	[c] 715,057	[c] 8,844	[c] 8,862	[d]	[d]	[d]
Spain	29+	21,594	13,155	14,328	14,178	57,474	77,714	66,685
Sweden	.....	4,001	3,643	7,607	8,894	19,873	16,570	12,278
United Kingdom	30+	5,480	3,492	4,714	5,222	10,101	17,736	12,272
Africa:								
Gold Coast	.....	.....	.....	.....	[e]	[e]	30,777	35,754
Tunis	.....	.....	.....	1,460	2,027	5,970	820	1,313
Union of South Africa	.....	.....	.....	.....	.....	112	494	141
Asia:								
China	.....	.....	.....	.....	.....	[a] 20	[a] 3,048	[a] 1
India	47–52	828,128	693,858	457,646	664,704	600,296	526,266	543,582
Japan	50+	18,259	17,067	25,871	49,310	51,374	[f] 29,759	[f] 9,555
Oceania:								
Australia	40+	27	26	556	1,292	290	9,034	5,049

[a] Imports into the United States. Production and exports not available.
[b] Official. Commerce reports give production as 2,294 metric tons, and imports into the United States from Mexico were 6,396 metric tons in 1919.
[c] Exports.
[d] Not available.
[e] Shipments June, 1916, to November, 1917, 31,482 metric tons.
[f] Official figures covering all mines that produced over 375 metric tons. Unofficial figures for all mines were 59,000 metric tons for 1918 but are not yet available for 1919.

Manganese ore produced in principal producing countries, 1913 to 1919, in gross tons.

Country.	Percentage of manganese.	1913	1914	1915	1916	1917	1918	1919
North America:								
Canada			25	180	854	141	393	[a] 582
Costa Rica	37–48				[a] 1,244	[a] 7,163	[a] 9,680	[a] 9,988
Cuba	36–44			[a] 5,141	[a] 30,563	[a] 44,511	[a] 82,974	[a] 35,320
Mexico	40+					72	2,833	[b] 112
Panama	50±				[a] 10,498	[a] 5,202	[a] 5,607	[a] 2
Porto Rico	35+				[c] 738	[c] 1,189	[c] 1,350	[d]
United States	35+	4,048	2,635	9,613	31,474	129,405	305,869	55,322
South America:								
Brazil	38–50	120,368	180,729	284,111	495,182	524,438	[a] 345,877	[a] 246,592
Chile	40–48					[a] 202	[a] 2,998	[a] 441
Ecuador							[a] 107	[a] 20
Peru							[a] 20	
Europe:								
Austria		16,279	13,590	11,738	[d]	[d]	[d]	[d]
Belgium				492	3,809	2,008	2,569	
Bosnia and Herzegovina		5,708	[d]	10,257	22,316	48,079	[d]	[d]
France	30+	7,610	6,292	10,161	10,636	11,406	9,715	4,739
Germany	30+	748	[d]	[d]	[d]	[d]	[d]	[d]
Greece				402	3,543		[d]	[d]
Hungary		18,706	14,185	[d]	[d]	88,843	[d]	[d]
Italy	18–45	1,596	1,623	12,379	17,860	24,144	31,392	30,354
Russia	41–48	1,289,370	[c] 703,762	[c] 8,705	[c] 8,722	[d]	[d]	[d]
Spain	29+	21,254	12,947	14,102	13,954	56,566	76,486	65,632
Sweden		3,938	3,585	7,487	8,754	19,559	16,308	12,084
United Kingdom	30+	5,393	3,437	4,640	5,140	9,942	17,456	12,078
Africa:								
Gold Coast					[e]	[e]	30,291	35,189
Tunis				1,437	1,995	5,876	807	1,292
Union of South Africa						111	486	138
Asia:								
China						[a] 20	[a] 3,000	[a] 1
India	47–52	815,047	682,898	450,417	654,204	590,813	517,953	534,995
Japan	50+	17,971	16,797	25,462	48,531	50,562	[f] 29,289	[f] 9,404
Oceania:								
Australia	40+	27	26	547	1,272	285	8,891	4,969

[a] Imports into the United States. Production and exports not available.
[b] Official. Commerce reports give production as 2,258 gross tons, and imports into the United States from Mexico were 6,295 gross tons in 1919.
[c] Exports.
[d] Not available.
[e] Shipments June, 1916, to November, 1917, 30,985 gross tons.
[f] Official figures covering all mines which produced over 369 gross tons. Unofficial figures for all mines were 58,000 gross tons for 1918 but are not yet available for 1919.

FERRUGINOUS MANGANESE ORE.

The shipments of ores containing 10 to 35 per cent of manganese in 1919, were 309,834 gross tons, valued at $1,182,528. The quantity was about 66 per cent lower than in 1918, and the value was about 74 per cent lower. The shipments from the Cuyuna range, though less than in any other year since 1915, compared better with the shipments of 1918 than those from any other district. The decrease was 486,057 tons. The shipments from Colorado decreased tremendously, the decrease being 82,860 tons. Fifty-seven per cent of all ore shipped from the Leadville district in 1919 was used as fluxing ore, and the remainder was used in making manganese alloys.

Ferruginous manganese and manganiferous iron ores shipped from the Cuyuna district, Minn., 1913–1919, in gross tons.

Mine.	Ore containing 10 to 35 per cent of manganese.							Ore containing 5 to 10 per cent of manganese.							Total.
	1913	1914	1915	1916	1917	1918	1919	1913	1914	1915	1916	1917	1918	1919	
Algoma (Hoch)	.....	192	7,600	23,000	[a] 84,125	21,200	24,478	.....	.....	.....	.....	.....	.....	.....	[a] 160,595
Arko	.....	.....	.....	.....	.....	733	500	.....	.....	.....	.....	.....	.....	.....	1,233
Cuyuna Mille Lacs	[b] 26,200	55,000	35,221	90,000	112,554	132,515	.....	.....	.....	.....	.....	.....	25,560	.....	477,050
Ferro	.....	.....	.....	14,710	(a)	57,261	14,556	.....	.....	.....	.....	.....	.....	.....	[a] 86,527
Gloria	.....	.....	.....	.....	.....	.....	2,637	.....	.....	.....	.....	.....	.....	.....	2,637
Hillcrest	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,712	9,590	20,242	.....	32,544
Hopkins	.....	.....	.....	.....	.....	36,651	5,849	.....	.....	.....	.....	.....	.....	.....	42,500
Ida Mae	.....	.....	.....	.....	.....	5,134	.....	.....	.....	.....	.....	.....	.....	.....	5,134
Joan, Nos. 1 and 4	.....	.....	.....	.....	8,375	27,931	.....	.....	.....	.....	.....	.....	.....	.....	36,306
Mahnomen	.....	.....	.....	(c)	4,000	132,726	11,472	.....	.....	.....	[c] 43,000	82,000	175,648	90,896	539,742
Mangan, Nos. 1 and 2	.....	.....	.....	30,329	52,290	67,796	92	.....	.....	.....	.....	.....	4,679	.....	155,186
Martin	.....	.....	.....	.....	.....	349	.....	.....	.....	.....	.....	.....	1,073	.....	1,422
Merritt, No. 1	.....	.....	.....	.....	33,180	78,555	.....	.....	.....	.....	.....	.....	.....	.....	111,735
Sagamore	.....	.....	.....	.....	.....	.....	79,248	.....	.....	.....	.....	.....	.....	7,324	86,572
Sultana	.....	.....	152	35,218	65,018	64,158	120	.....	.....	.....	.....	.....	.....	.....	164,666
	[b] 26,200	55,192	42,973	193,257	359,542	625,009	138,952	.....	.....	.....	45,712	91,590	227,202	98,220	1,903,849

[a] Shipments from Ferro mine included with Algoma mine for 1917. Not reported separately to the Geological Survey.
[b] Percentage of manganese not stated.
[c] Shipments from Mahnomen mine in 1916 averaged 5 to 14 per cent of manganese. Not reported in greater detail to the Geological Survey.

Manganiferous silver ore shipped, 1907–1919, in gross tons.

Year.	Arizona.	Colorado.		Nevada.	New Mexico.	Utah.
		For fluxing.	For other purposes.			
1907		32,197	67,514			
1908		35,581	15,973			
1909		52,119	12,905			
1910		55,770				
1911		41,753				
1912		48,618				
1913		49,753				
1914		37,781	2,100			
1915	[a] 1,452	14,965	15,956	104,498		55
1916	[a] 7,392	16,263	90,600	122,429		27
1917	[a] 32,009	20,546	104,169	122,872		100
1918	[a] 10,854	24,931	99,110	80,096	475	
1919	[a] 1,964	29,769	11,055	77,815	250	

[a] Ore containing more than 35 per cent of manganese sent to makers of manganese alloys not included.

VALUE OF MANGANESE ORES.

In general the value of materials that contain manganese depends on the composition, the minerals present, and the condition or state of aggregation of the material. The value depends largely, of course, on the content of metallic manganese, but incidentally on the absence of such substances as phosphorus, silica, copper, cobalt, and iron. For certain purposes, other things being equal, it depends on the amount of oxygen which will be liberated under certain conditions, and this is different for the several oxidized minerals. If manganese alloys are to be produced in the blast furnace, the material should be in coherent lumps, as fine sand and powder can not be treated to advantage. On the other hand, if the material is to be used to make dry batteries or flint glass and is not already in finely divided condition it should be crushed and pulverized.

The value of an ore adapted to use as an oxidizer in dry batteries and flint glass varies with its content of manganese dioxide and, in contradistinction to the value of ores used in metallurgic industries, depends only indirectly on its content of metallic manganese. As much of the ore of the Caucasus region contains from 85 to 92 per cent of manganese dioxide and less than 1 per cent of iron and is therefore admirably adapted to these uses, most specifications for ores to be put to these uses before the war were such as could be met by ore from the Caucasus region, but only rarely by ores from other regions. According to one manufacturer of dry batteries, as long as Caucasian ore was available there was little experimentation to determine the suitability of the several manganese minerals and the limits beyond which other elements than manganese may be present. As a result of recent experiments, it has been shown that copper, nickel, and cobalt are the most harmful elements in the ordinary dry battery and should not be present in even minute quantities. A few tenths of 1 per cent of any of these elements renders an ore unfit for this use. On the other hand, it is stated that more than 2 or 3 per cent of iron as oxide does not necessarily greatly affect the efficiency of a battery and that the 1 per cent limit is arbitrary. It is estimated that the present demand for man-

ganese ore for dry batteries and flint glass is about 35,000 tons a year.

The value of ferruginous manganese ores, manganiferous iron ores, and manganiferous silver ores depends on local conditions in the metallurgic industries that consume them, as the manganese content is used only indirectly. In both Minnesota and Colorado it is customary to pay a flat rate for ore having a certain percentage of manganese, iron, silica, moisture, and phosphorus. For each additional per cent of manganese a premium is paid, and for each additional per cent of silica or moisture a penalty is charged.

Manganiferous zinc residuum is rarely sold in the open market, but is smelted to spiegeleisen by the only company that produces it.

MANGANIFEROUS ZINC RESIDUUM.

Unique deposits of zinc ore containing franklinite, willemite, zincite, calcite, and minor silicate and other minerals occur near Franklin Furnace, N. J. By mechanical and electromagnetic processes of separation three products are obtained from these ores, one containing the greater part of the franklinite and the remaining two the other zinc minerals. The franklinite product is first roasted with anthracite to eliminate the zinc, which is recovered as zinc oxide, and the residue, containing 12 to 15 per cent of manganese and 40 per cent of iron, is smelted to spiegeleisen.

Manganiferous residuum produced from zinc roasting in the United States, 1910–1919, in gross tons.

1910	137,173	1915	159,318
1911	109,296	1916	198,817
1912	104,670	1917	155,332
1913	102,239	1918	146,796
1914	100,198	1919	80,418

FERROMANGANESE AND SPIEGELEISEN.

Ferromanganese and spiegeleisen are essentially alloys of manganese, iron, and carbon, although in the ordinary processes of manufacture it is impossible to prevent the presence of small quantities of silicon and phosphorus. Their use depends upon the effects produced by the addition of small quantities of manganese and carbon to molten steel. It is commonly stated that a part of the manganese combines with any oxygen in the molten steel and the remainder increases the tensile strength of the steel and that the carbon raises the percentage of that element to the desired proportion. The name spiegeleisen (German, mirror iron) was given on account of the highly brilliant plates that develop when the alloy with 15 to 20 per cent of manganese crystallizes. It commonly contains manganese, 20 per cent; iron, 75 per cent; and carbon, 5 per cent. The ratio of manganese to carbon is therefore 4 to 1. Ferromanganese commonly contains manganese, 78 to 82 per cent; iron, 13 per cent; and carbon, 7 per cent. The ratio of manganese to carbon is therefore about 12 to 1. There appears to be no natural division between the manganese contents of spiegeleisen and ferromanganese, but 40 per cent is commonly accepted by the steel trade.

Spiegeleisen was the first alloy to be developed, and it was added to all steel made by the Bessemer and open-hearth processes until

about 1875, when ferromanganese became a commercial product. For many years thereafter spiegeleisen was used only in making so-called "medium" and "high-carbon" steels (those containing more than 0.25 per cent of carbon) by the Bessemer process, whereas ferromanganese was used in making "low-carbon" steel (that containing less than 0.25 per cent of carbon). It can readily be understood that for a given quantity of manganese in the form of alloys added to the molten steel three times as much carbon is added if spiegeleisen is used than if ferromanganese is used. During recent years, even before the outbreak of war in 1914, many steel makers have experimented with the use of alloys in which the manganese content ranged between that in spiegeleisen and that in ferromanganese, as well as other alloys, such as silicomanganese. The use of several of the alloys for special purposes has been fairly established, and, although a few steel makers have contended that in spite of the low ratio of manganese to carbon, alloys with 15 to 35 per cent of manganese could be used to make steel with 0.10 to 0.25 per cent of carbon, the practice has not come into wide use.

During 1919 the domestic production of ferromanganese was 185,357 tons and imports were 33,022 tons. As a result of the recommendations in April, 1918, of the American Iron and Steel Institute to its members the grade of most of the ferromanganese made in the United States during 1918 was reduced from 80 to 70 per cent of manganese and of spiegeleisen from 20 to 16 per cent of manganese. Some makers made large quantities of ferromanganese containing 60 to 65 per cent of manganese. The imported material contained about 80 per cent of manganese.

The firms that make ferromanganese and spiegeleisen are listed below (f indicates ferromanganese; s, spiegeleisen):

fs—American Manganese Manufactufing Co., Dunbar, Pa.
f—Anaconda Copper Mining Co., Great Falls, Mont.
f—B. & B. Trading Co., Troy, N. Y.
fs—Bethlehem Steel Corporation, Lebanon, Pa.
f—Bilrowe Alloys Co., Tacoma, Wash.
fs—Cambria Steel Co., Widener Building, Philadelphia, Pa.
s—Colorado Fuel & Iron Co., Pueblo, Colo.
f—Donner Steel Co., North Tonawanda, N. Y.
fs—J. B. Guernsey & Co., Graham, Va.
s—J. B. Guernsey & Co., Roanoke, Va.
fs—Juniata Furnace & Foundry Co., Newport, Pa.
f—Lavino Furnace Co., Lebanon, Pa.
fs—Lavino Furnace Co., Marietta, Pa., and Reusens, Va.
s—Lavino Furnace Co., Sheridan, Pa.
f—E. E. Marshall, Harrisburg, Pa.
fs—Miami Metals Co., South Chicago, Ill.
fs—Midvale Steel & Ordnance Co., Johnstown, Pa.
f—National Alloy Co., Twenty-fifth and Dickinson streets, Philadelphia, Pa.
s—New Jersey Zinc Co., Palmerton, Pa.
f—Noble Electric Steel Co., Heroult, Calif.
f—Pacific Alloy & Steel Co., Bay Point, Calif.
f—Pittsburg Radium Co., Denver, Colo.
fs—Seaboard Steel & Manganese Corporation, Temple, Pa.
f—Seattle Smelting Co., Seattle, Wash.
fs—Southeastern Iron Corporation, Goshen, Va.
fs—Southern Manganese Corporation, Anniston, Ala.
fs—Tennessee Coal, Iron & Railroad Co., Bessemer and Birmingham, Ala.
f—Tennessee Manganese Co., Cleveland, Tenn.
fs—United States Steel Corporation, Chicago, Ill., and Pittsburgh, Pa.
f—Western Reduction Co., Portland, Oreg.

Ferromanganese and spiegeleisen shipped from furnaces in the United States, 1911–1919.

Year.	Ferromanganese.		Spiegeleisen.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
1911	74,602	[a] $4,746,541	104,013	(a)
1912	125,378	[a] 8,282,006	102,561	(a)
1913	119,495	[a] 9,272,269	106,980	(a)
1914	100,731	4,440,253	76,625	$1,586,139
1915	144,260	9,253,443	114,556	2,403,550
1916	224,103	30,123,493	182,837	6,158,202
1917	260,225	53,930,771	189,241	9,756,236
1918	306,076	69,045,678	263,861	17,276,494
1919	[b] 185,357	[c] 21,281,000	[b] 84,246	[c] 3,235,000

[a] Value for spiegeleisen included with that for ferromanganese.
[b] Figures of production according to the American Iron and Steel Institute.
[c] Estimated by the United States Geological Survey. Final figures not yet available.

Ferromanganese and spiegeleisen imported for consumption in the United States, 1903–1919.

Year.	Ferromanganese.		Spiegeleisen.		Total.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
1903–1909	421,490	$19,856,699	355,857	$9,001,704	777,347	$28,858,403
1910	114,228	4,341,071	25,383	489,049	139,611	4,830,120
1911	80,263	3,015,062	20,970	405,444	101,233	3,420,506
1912	99,137	3,906,920	1,015	28,094	100,152	3,935,014
1913	128,070	5,682,915	77	2,173	128,147	5,685,088
1914	82,997	3,619,607	2,870	71,147	85,867	3,690,754
1915	55,263	3,333,699	200	5,110	55,463	3,338,809
1916	90,928	9,240,528	.....	.....	90,928	9,240,528
1917	41,969	5,710,988	3,968	291,594	45,937	6,002,582
1918	27,168	4,258,745	1,969	228,012	29,137	4,486,757
1919	33,022	4,283,541	27	1,018	33,049	4,284,559
	1,174,535	67,249,775	412,336	10,523,345	1,586,871	77,773,120

The following records of average contract prices of ferromanganese at eastern seaboard points and of spiegeleisen at furnaces by months for the last four years are of interest. Prices on ferromanganese from May, 1918, to and including January, 1919, are based on 70 per cent of manganese, and other prices on 80 per cent; prices on spiegeleisen from April, 1918, to and including June, 1919, are based on 16 per cent of manganese and other prices on 20 per cent.

Prices per gross ton of ferromanganese and spiegeleisen, 1916–1919.[a]

Month.	Ferromanganese.				Spiegeleisen.			
	1916	1917	1918	1919	1916	1917	1918	1919
January	$110.00	$175.00	$250.00	$212.50	$32.50	$57.50	$59.00	$67.50
February	140.00	192.50	250.00	165.00	42.50	66.25	59.00	52.50
March	175.00	212.50	250.00	134.00	55.00	77.50	65.50	42.50
April	175.00	250.00	250.00	113.75	60.00	76.75	70.00	34.50
May	175.00	375.00	250.00	110.00	60.00	78.00	71.00	31.35
June	175.00	400.00	250.00	111.75	55.00	83.00	75.00	27.50
July	175.00	400.00	250.00	111.00	47.50	85.00	75.00	34.00
August	170.00	387.50	250.00	110.00	47.50	81.25	75.00	34.00
September	164.00	380.00	250.00	105.00	45.00	80.50	75.00	34.00
October	160.00	300.00	250.00	110.00	40.00	73.50	75.00	34.00
November	155.00	247.50	250.00	110.00	45.00	63.25	75.00	34.00
December	162.50	247.50	236.00	121.00	50.00	60.00	72.50	39.00

[a] Iron Trade Review.

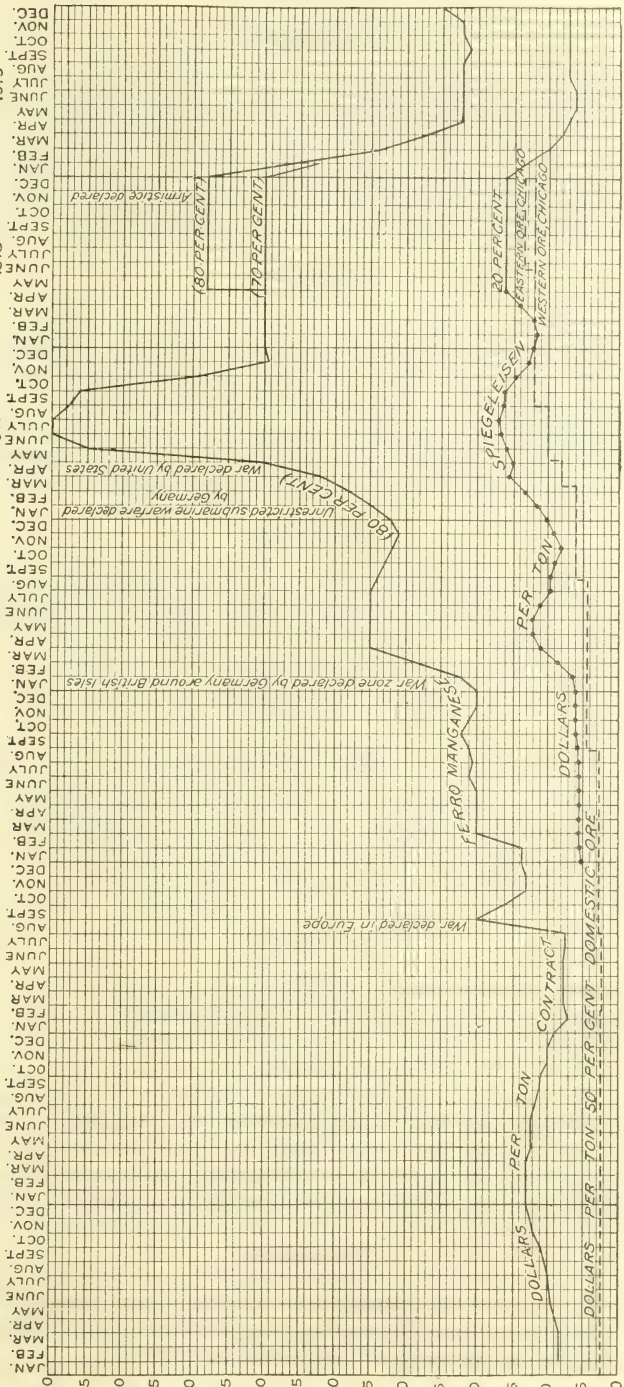

FIGURE 2.—Diagram showing contract prices of ferromanganese, spiegeleisen, and manganese ore, 1912–1919.

OPERATIONS IN 1919, BY STATES.

ALABAMA.

The Southern Manganese Corporation exploited two deposits of high-grade ore in the Altoona district of Alabama, but the production was comparatively small. The nature of the deposits for the most part is such that the proximity of the southern steel industry is not an advantage great enough to make production by Alabama producers possible upon a large scale at the present time.

ARIZONA.

The number of shippers of high-grade ore in Arizona decreased from 35 in 1918 to 5 in 1919, and the shipments of high-grade ore decreased 97 per cent. The Arizona ores, which can not be used for fluxing, are under a considerable disadvantage on account of their location and the expensive machinery necessary for concentration. Most of the deposits can not be exploited at present except under high prices continuing over a long period.

ARKANSAS.

The shipments of high-grade ore in Arkansas decreased from 7,731 tons in 1918 to 2,558 tons in 1919. The reaction that followed the signing of the armistice was more severe in this district than in most others. Many operators had just commenced production when the market conditions prevented further operation and caused considerable losses.

CALIFORNIA.

The number of operators in California decreased from 49 in 1918 to 9 in 1919, and the shipments fell from 24,135 gross tons to 11,289 tons. The ore produced was all derived from six counties—Alameda, Los Angeles, Riverside, San Joaquin, San Luis Obispo, and Stanislaus.

COLORADO.

Only three operators in Colorado produced high-grade ore in 1919, and of these not one maintained a large production during the last half of the year.

GEORGIA.

All the manganese and manganiferous ore produced in Georgia in 1919 was mined in Bartow County by three operators. The same conditions prevail in Georgia as elsewhere, and a large production of manganese ore can not be expected under the present conditions.

MICHIGAN.

All the low-grade manganese ore produced in Michigan was derived in 1919, as in 1918, from the Bengal iron mine. Shipments of ore from Michigan increased 6,623 tons in 1919.

MINNESOTA.

The action of the American Iron and Steel Institute in 1918 in urging all its members to reduce the grade of ferromanganese enabled the producers to maintain a relatively large production in 1919. The iron content of the ore and cheap transportation are decided advantages. The principal problems that have been encountered in the marketing of these ores appear to have been solved, and although 1919 was a very unfavorable year, under normal conditions these mines may be able to market large quantities of ore for some time to come.

MONTANA.

The Montana operators suffered the same troubles in 1919 that were experienced by other operators, and only six of them were able to produce during the year. The character, grade, and location of the Montana ores represent considerable advantages over most other districts and enabled the operators to make a production which compared favorably with the production of 1918.

NEVADA.

Only four operators in Nevada shipped ore in 1919. They were able to maintain a relatively large production because of the silver content of their ore and its value as a flux.

NEW MEXICO.

Six operators in New Mexico shipped manganiferous ore in 1919, and the shipments of low-grade ore showed a decided decrease in 1919. All the ore was derived from mines in Grant, Lincoln, and Sierra counties.

NORTH CAROLINA.

The shipments of all grades of manganese ore in North Carolina in 1919 were almost negligible, and apparently no great improvement can be expected.

TENNESSEE.

Six operators in Tennessee made a small production from Bradley, Carter, and Johnson counties. Part of the ore was suitable for use in the paint industry.

VIRGINIA.

A number of operators in Virginia made a discouragingly small production from Augusta, Bland, Frederick, Giles, Shenandoah, and Smyth counties. Considerable additional equipment had been installed in 1918, and the operators were in a position to increase their production greatly, but the grade and character of the ore prevented them from finding a market.

FOREIGN DEPOSITS OF MANGANESE ORE.

RUSSIA.

The manganese ore produced in Russia has been mined almost entirely in three districts—Tchiatouri, in the central part of the Caucasus; Nikopol, on Dnieper River a short distance north of the Black Sea; and the central part of the Ural Mountains. Manganese has been mined in these districts for more than 40 years, and since 1880 the production has been large. Until the recent revolutions and subsequent soviet control the output was made by concessionnaires operating under the authority of the Imperial Russian Government; but production has now stopped entirely.[7] In 1918 and 1919 very little ore was mined and 1,600 tons of ore shipped in December, 1919, represented the total exports for that period.

Under the soviet régime all mines have been "nationalized" and no production can be made except by the "government" or apparently under concessions which are concessions in name only. The rights and concessions that had been guaranteed by and secured from the imperial Government were entirely disregarded. Mines, buildings, and equipment were confiscated, and investors and operators were left without compensation or even the right of appeal. How long this deplorable state of affairs will last can not be determined. However, there is good reason to believe that the soviet rulers are offering concessions, and the time may not be far off when these concessions will be of such a nature that they would be, politically and commercially, a comparatively safe undertaking. It does not seem possible that the present conditions can last much longer, and if stable conditions return the Russian manganese resources must be regarded as perhaps the world's greatest potential reserves. As will be seen from the following table the Tchiatouri deposits are the largest.

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[7] U. S. Consul at Tiflis, Republic of Georgia.

Manganese ores produced in Russia, 1879–1910.

Gross tons.

Year.	Tchiatouri.	Ural.	Nikopol.	Total.
1879 [a]	871	.....	.....	871
1880 [b]	9,910	.....	.....	9,910
1881 [c]	11,048	.....	.....	11,048
1882	12,287	1,900	.....	14,187
1883	15,700	1,063	.....	16,763
1884	20,338	1,422	.....	21,760
1885 [d]	58,534	882	.....	59,416
1886	67,956	809	3,555	72,320
1887	51,867	827	3,650	56,344
1888	29,388	1,333	1,445	32,166
1889	68,410	2,887	5,506	76,803
1890	168,766	2,314	8,514	179,594
1891	98,328	1,906	10,645	110,879
1892	165,029	908	28,940	194,877
1893	166,348	3,000	76,421	245,769
1894	179,237	1,748	57,429	238,414
1895	116,218	2,712	36,865	155,795
1896	156,485	4,022	44,865	205,372
1897	195,589	4,882	55,091	255,562
1898	262,131	6,388	58,692	327,211
1899	548,994	1,863	95,359	646,216
1900	650,740	2,820	87,186	740,746
1901	369,267	3,478	68,414	441,159
1902	417,962	6,055	56,490	480,507
1903	370,394	4,627	33,720	408,741
1904	350,027	4,837	59,540	414,404
1905	306,872	4,837	115,104	426,813
1906 [e]	.....	.....	.....	1,002,865
1907	.....	.....	.....	987,676
1908	.....	.....	.....	356,580
1909	.....	.....	.....	726,943
1910	.....	.....	.....	719,873
	.....	.....	.....	9,637,584

Metric tons.

1879 [a]	885	.....	.....	885
1880 [b]	10,069	.....	.....	10,069
1881 [c]	11,225	.....	.....	11,225
1882	12,484	1,930	.....	14,414
1883	15,952	1,080	.....	17,032
1884	20,664	1,445	.....	22,109
1885 [d]	59,473	896	.....	60,369
1886	69,047	822	3,612	73,481
1887	52,699	840	3,709	57,248
1888	29,860	1,354	1,468	32,682
1889	69,508	2,933	5,595	78,036
1890	171,475	2,351	8,650	182,476
1891	99,906	1,937	10,816	112,659
1892	167,678	923	29,404	198,005
1893	169,018	3,048	77,648	249,714
1894	182,114	1,776	58,351	242,241
1895	118,083	2,756	37,457	158,296
1896	158,996	4,087	45,585	208,668
1897	198,728	4,960	55,976	259,664
1898	266,338	6,491	59,634	332,463
1899	557,805	1,893	96,890	656,588
1900	661,184	2,866	88,586	752,636
1901	375,194	3,534	69,512	448,240
1902	424,670	6,152	57,397	488,219
1903	376,339	4,701	34,261	415,301
1904	355,644	4,915	60,496	421,055
1905	311,797	4,915	116,951	433,663
1906 [e]	.....	.....	.....	1,018,961
1907	.....	.....	.....	1,003,528
1908	.....	.....	.....	362,303
1909	.....	.....	.....	738,610
1910	.....	.....	.....	731,427
	.....	.....	.....	9,792,267

[a] Drake, F., The manganese-ore industry of the Caucasus; Am. Inst. Min. Eng. Trans., vol. 28, p. 191, 1898 (statistics for 1879).

[b] U. S. Geol. Survey Mineral Resources, 1886, p. 205, 1887 (statistics for 1880).

[c] U. S. Geol. Survey Sixteenth Ann. Rept., pt. 3, p. 444, 1895 (statistics for 1881–1884).

[d] U. S. Geol. Survey Mineral Resources, 1905, p. 105, 1906 (statistics for 1885–1905; changed from poods to gross tons).

[e] Reports of British Home Office: Mines and Quarries, 1907–1912 (statistics for 1906–1910; changed from metric tons to gross tons).

TCHIATOURI DISTRICT.

The Tchiatouri district is in the Government of Kutais, and the deposits lie along the edge of a high plateau that rises about 1,000 feet above the valleys of Kvrilli River and its branches. The mines are reached by a narrow-gage spur from the main line of the Transcaucasian Railway, whose termini are Baku, on the Caspian Sea, and Batum and Poti, on the Black Sea. The spur branches from the main line at Kvrilli and ascends the Kvrilli Valley to Tchiatouri, a distance of about 21 miles.

The rocks of the region are principally Cretaceous and Tertiary sediments[8] lying in very regular beds with a dip of about 2°–3° NE. and are very well exposed along the cliffs of the Kvrilli Valley. At the base of the cliffs are Cretaceous shales and chalks, which are overlain by Eocene sandstones and associated sediments, which in turn are overlain by Oligocene and Miocene sandstone, shale, and chalk.

The occurrence of the ore and the presence of fossils in the ore itself clearly indicate its sedimentary origin. According to Stelzner and Bergeat[9] the beds of manganese ore occur between the Cretaceous chalk at the bottom and the Eocene sandstones at the top. Others place the ore beds entirely in the Miocene sandstone. Kvrilli River and its tributaries have dissected the plateau,[10] and their canyons expose the rocks and the ore beds. The ore beds occur on the upper slopes of the canyons on both sides of the valley from 700 to 1,000 feet above its bottom. The total area underlain by manganese ore is about 55 square miles, about 22 square miles of which probably contain good ore.[11] The ore beds consist of a series of layers of low-grade ores, high-grade ore, sandstone, and loose, friable calcareous rock of variable thickness. The total thickness of the series ranges from 6 to 7 feet, a little more than 3 feet of which is manganese ore. The deposit is distinctly stratified. The principal manganese mineral is pyrolusite, though there are small quantities of wad and psilomelane. The ore is largely oolitic and concretionary, much of it showing concentric and botryoidal structure, and the oolites and concretions are embedded in a matrix of soft ore.

Granules of the ore occur in the associated sandstone. The reserves of high-grade ore are variously estimated at 45,000,000 to 110,000,000 metric tons—enough to supply the requirements of the American steel industry at the rate of production in 1918 for 50 to 120 years.

The average manganese content of the ore is about 40 to 45 per cent, though some of it runs as high as 52 per cent without sorting or cleaning. Concentrates prepared by washing contain from 80 to 90 per cent of manganese dioxide. The ore as exported averages about 50 per cent of manganese, 6 to 8 per cent of silica, 1 per cent of iron, and not more than 0.17 per cent of phosphorus. The

[8] Beyschlag, F., Krusch, P., and Vogt, J. H. L., Lagerstätten der nutzbaren Mineralien und Gesteine, Band 2, p. 592, 1913.
[9] Stelzner, A., and Bergeat, A., Die Erzlagerstätten, p. 258, 1904.
[10] Cauldwell, F. W., Manganese ore in the Caucasus: Daily Cons. and Trade Repts., May 7, 1912.
[11] Drake, Frank, The manganese-ore industry of the Caucasus: Am Inst. Min. Eng. Trans., vol. 28, pp. 191–208, 1898.

principal disadvantage of the ore is the small proportion of large pieces, and much of it is so soft that handling grinds it into a fine powder, which is objectionable and may occasion considerable losses in mining, milling, and concentration.

Until a few years ago the mines were owned and operated by peasants who had no capital or knowledge of mining, and with their primitive methods recovered only about two-thirds of the ore mined. A few years before the war foreign capitalists gained control of a large part of the deposit and instituted modern methods of mining.

Most of the ore is transported by rail to Poti, about 90 miles, or to Batum, about 126 miles, and thence by steamers. A large part of the ore that was exported to the United States was transshipped in England or Germany. The following table given by Harder [12] indicates the total cost per ton of the ore delivered at Batum and Poti.

Cost per ton of manganese ore from Tchiatouri, Russia.

	At Poti.	At Batum.
Mining	$1.45	$1.45
Transportation to Tchiatouri	.83	.83
Transportation to Sharopan	1.77	1.77
Transshipment and loading	.40	.40
Transportation to port	.52	.84
Port charges, taxes, etc	.72	.46
	5.69	5.75

NIKOPOL DISTRICT.

The Nikopol district, though not comparable in output of manganese ore with the Tchiatouri district, produces more than the Ural district. The manganese deposits occur near Nikopol, on Dnieper River, about 100 miles north of the Gulf of Odessa. These deposits have been worked since 1886, and their production steadily increased until 1915. In nature and occurrence the deposits, though much smaller, are similar to those of Tchiatouri. The ore occurs in a horizontal bed in Oligocene rocks.[13] Glauconitic sand and clay largely form both the hanging wall and the footwall. Granite and gneiss occur immediately below the Oligocene strata and in places only a few feet below the manganese ore bed. The ore-bearing bed consists principally of psilomelane and pyrolusite, with a few less common manganese minerals mixed with sandy clay. The manganese minerals are cellular or concentric in structure and occur largely as nodules. The better grade of ore contains about 57 per cent of manganese.

The area underlain by the manganese ore is reported to be about 20 square kilometers, and the bed ranges in thickness from 1 to 1.5 meters. The total available quantity is estimated at 7,400,000 metric tons.

[12] Harder, E. C., Manganese ores of Russia, India, Brazil, and Chile: Am. Inst. Min. Eng. Trans., September, 1916, p. 37.
[13] Beyschlag, F., Krusch, P., and Vogt, J. H. L., op. cit., p. 593.

INDIA.

Manganese ore has been mined in India in considerable quantity since 1892. The output increased so rapidly that since 1915 India has been the leading manganese-producing country in the world.

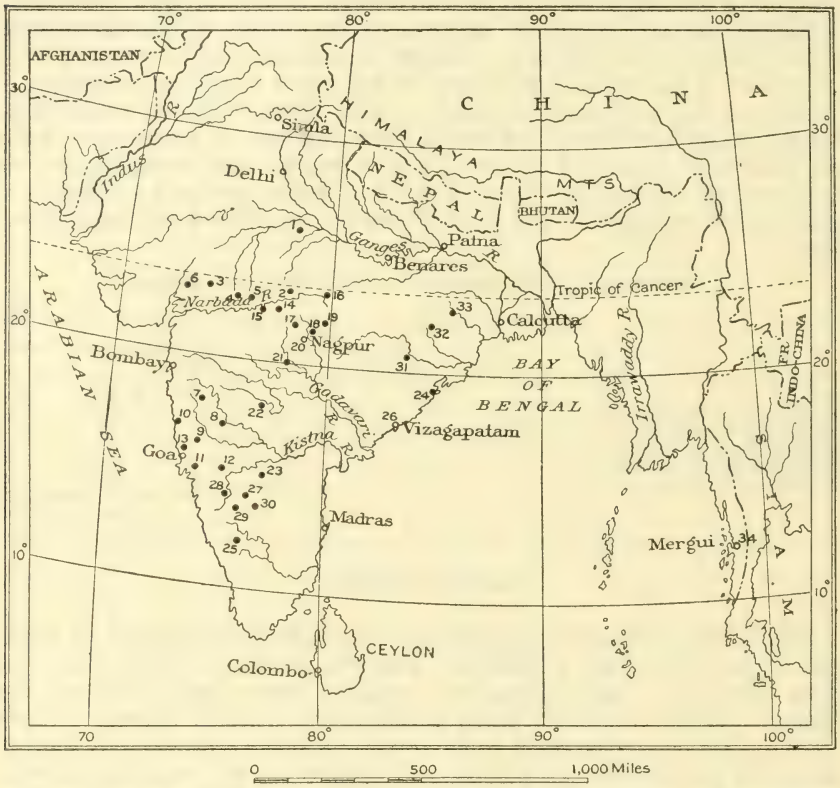

FIGURE 3.—Map of India showing the location of the principal deposits of manganese ore. (Adapted from a map by Fermor.) 1, Gwalior; 2, Bhopal; 3, Jhabua; 4, Dhar; 5, Indore; 6, Narukot and Panch Mahals; 7, Satara; 8, Bijapur; 9, Belgaum; 10, Ratnagiri; 11, North Kanara; 12, Dharwar; 13, Bicholim; 14, Hoshangabad; 15, Nimar; 16, Jabalpur; 17, Chhindwara; 18, Balaghat; 19, Bhandara; 20, Nagpur; 21, Wun; 22, Bidar; 23, Bellary; 24, Ganjam; 25, Nilgiri Hills; 26, Vizagapatam; 27, Chitaldrug; 28, Shimoga; 29, Kadur; 30, Tumkur; 31, Kalahandi; 32, Gangpur; 33, Singhbhum; 34, Mergui.

Manganese deposits occur in a great many places in India; the largest are in the localities shown in figure 3.

The following table compiled by Harder[14] shows the production from all the important districts:

[14] Harder, E. C., op. cit., p. 771.

Manganese ore produced in India, 1892–1913.[a]

Gross tons.

	1892–1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Bengal:															
Gangpur									2,000	20,000	55,060	41,958	25,152	27,173	11,215
Singhbhum								1,000							
Bombay:															
Belgaum							640	234	22,125	23,232					
Panch Mahals								7,286			17,657	30,396	45,330	43,538	40,914
Ratnagiri												525			
Central India:															
Jhabua					6,800	11,564	30,251	50,073	35,743	13,315	10,324	12,664	7,319	5,652	6,814
Central Provinces:															
Balaghat			3,839	1,975	7,898	10,323	16,246	102,260	167,713	135,487	134,577	161,987	144,642	135,435	219,139
Bhandara			499	5,360	4,998	8,559	35,238	96,017	285,248	110,673	110,856	159,164	119,606	115,365	89,818
Chhindwara								7,486	24,936	49,008	17,464	19,556	1,540	16,517	78,583
Jubbulpore (Jabalpur)										48		300			
Nagpur		47,257	76,925	68,819	95,051	66,142	100,063	146,117	208,675	135,839	118,388	211,232	179,263	147,225	261,767
Madras:															
Bellary												500			
Sandur							1,200	3,209	151,890	118,089	78,636	73,666	66,950	62,488	52,169
Vizagapatam	309,998	92,008	76,473	68,171	63,074	53,602	63,789	111,501			59,818	46,441	58,915	54,758	44,127
Mysore:															
Shimoga and other districts								46,312		68,624	41,880	42,518	21,573	24,929	10,501
	309,998	139,265	157,736	144,325	177,821	150,190	247,427	571,495	[b] 898,345	674,315	644,660	800,907	670,290	633,080	815,047

[a] Fermor, L. L., quoted by Harder, E. C., op. cit.

[b] Includes 15 tons extracted in Lus Bela, Baluchistan, under a prospecting license.

Manganese ore produced in India, 1892–1913 [a]—Continued.

Metric tons.

	1892–1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910	1911	1912	1913
Bengal:															
Gangpur									2,032	20,321	55,944	42,631	25,556	27,609	11,395
Singhbhum								1,016							
Bombay:															
Belgaum							650	238	22,480	23,605	17,940	30,884	46,058	44,236	41,571
Panch Mahals								7,301							
Ratnagiri												533			
Central India:															
Jhabua					6,909	11,750	30,737	50,877	36,317	13,529	10,490	12,867	7,436	5,743	6,923
Central Provinces:															
Balaghat			3,901	2,007	8,025	10,489	16,507	103,902	170,405	137,662	136,736	164,586	146,963	137,608	222,656
Bhandara			507	5,446	5,078	8,696	35,804	97,558	289,826	112,449	112,634	161,718	121,525	117,216	91,260
Chhindwara								7,606	25,336	49,795	17,744	19,870	1,565	16,782	79,844
Jubbulpore (Jabalpur)										49		305			
Nagpur		48,015	78,160	69,924	96,577	67,204	101,669	148,462	212,024	138,019	120,287	214,621	182,138	149,587	265,968
Madras:															
Bellary												508			
Sandur							1,219	3,261	154,328	119,984	79,898	74,848	68,025	63,492	53,006
Vizagapatam	314,974	93,485	77,700	69,265	64,086	54,462	64,813	113,291			60,778	47,186	59,861	55,636	44,835
Mysore:															
Shimoga and other districts								47,055		69,725	42,556	43,205	21,921	25,332	10,670
	314,974	141,500	160,268	146,642	180,675	152,601	251,399	580,567	[b] 912,763	685,138	655,007	813,762	681,048	643,241	828,128

[a] Fermor, L. L., quoted by Harder, E. C., op. cit.

[b] Includes 15 tons extracted in Lus Bela, Baluchistan, under a prospecting license.

L. L. Fermor[15] has given an excellent description of the Indian deposits, and the following material is very largely taken from his work.

Practically all the important manganese-ore deposits of India occur in pre-Paleozoic rocks, which are classified as follows:[16]

Purana: Unfossiliferous sediments, such as quartzite, sandstone, slate, shale, conglomerate, and limestone. Here are included the Vindhyan, Bijawar, Kadapah, and Kaladgi series.

Archean: (1) Plutonic intrusives, such as Bundelkhand granite, banded granite, and gneissose granite. (2) Dharwar sediments: (*a*) Less metamorphosed—conglomerate, grit, phyllite, slate, quartzite, fine-grained limestone, and banded hematite and magnetite-jaspers, including the Aravalli, Chilipi Ghat, and Champaner series; (*b*) strongly metamorphosed and recrystallized—schistose gneiss, quartzite, quartzite schist, mica schist, and crystalline limestone, including also the gondite rocks. (3) The oldest gneisses, such as the Bengal gneiss, and metamorphosed sediments and igneous rocks, such as the charnockite, khondalite, and kodurite series.

As regards the geologic horizons at which they occur, the Indian manganese deposits are grouped as follows:

Recent (lateritic, lateritoid, concretionary, and other surface concentrations); Belgaum, Bijapur, Dharwar, North Kanara, Jabalpur, Bidar, Ganjam, Nagpur, Bhandara, Satara, Dhar, Indore, Nimar, Wun, Bhopal, Hoshangabad, Gawlior, and Nilgiri Hills.

Pre-Paleozoic (interlayered beds and lenses): (1) Dharwar and related rocks—(*a*) Less metamorphosed facies (Dharwar), Jhabua, Panch Mahals, Balaghat, Belgaum, Dharwar (Sangli State), North Kanara, Jabalpur, Bellary (Sandur Hills), Chitaldrug, Kadur, Shimoga, Tumkur, Singhbhum, Kalahandi, and Goa (Portuguese); (*b*) strongly metamorphosed facies (gondite series), Balaghat, Bhandara, Chhindwara, Nagpur, Narukot, and Gangpur. (2) The oldest gneisses and related rocks (khondalite and kodurite series): Vizagapatam and Ganjam.

Of the manganese occurrences enumerated above those of proved economic importance are in the Jhabua district of Central India; the Panch Mahals district of Bombay; the Chhindwara, Balaghat, Bhandara, and Nagpur districts of the Central Provinces; the Sandur and Vizagapatam districts of Madras; the Shimoga district of Mysore; and the Gangpur district of Bengal. Small quantities of ore have been produced in the Singhbhum district of Bengal, the Belgaum and Ratnagiri districts of Bombay, the Jabalpur district of the Central Provinces, and the Chitaldrug, Tumkur, and Kadur districts of Mysore. The annual production of manganese ore in India, by districts, in gross tons since 1892 is shown in the table on page 119.

All the important manganese-ore deposits in India known at present, except those of Vizagapatam, occur in one of the facies of the Dharwar rocks. Brief descriptions of the principal districts are given below.

CENTRAL PROVINCES.

BALAGHAT, BHANDARA, CHHINDWARA, AND NAGPUR DISTRICTS.[17]

The Balaghat, Bhandara, Chhindwara, and Nagpur districts are in the Central Provinces. The Balaghat, the easternmost district, is about 627 miles from Bombay, and Nagpur, the westernmost dis-

[15] Fermor, L. L., The manganese ore deposits of India: India Geol. Survey Mem., vol. 37, pts. 1–4.

[16] Fermor, L. L., quoted by Harder, E. C., op. cit.

[17] Harder, E. C., op. cit., p. 45.

trict, is about 520 miles from Bombay. The deposits are served by the Bengal-Nagpur Railway, and though many of the mines are on the railway a large part of the ore must be carted considerable distances. A proposed new railway will, however, eliminate most of the cartage.

Production was begun in these districts in 1900, when the Central Provinces Prospecting Syndicate made its first shipments of ore from the Nagpur district. The operations of this company were soon extended to the Balaghat and Bhandara districts and increased so rapidly that its production in 1906 amounted to about 283,000 gross tons. This company was soon followed in the Bhandara district by the Central India Manganese Co. (Ltd.), and in the Chhindwara district by the Indian Manganese Co. (Ltd.).

The deposits of the four districts occur in the Dharwar rocks, all except some of the Balaghat deposits in the recrystallized and more highly metamorphosed facies of the series. The metamorphism and recrystallization of these rocks is so extensive that the distinction between them and the oldest granites and gneisses is very difficult and they are usually classed together under the name "metamorphosed and crystalline complex." [18]

Fermor believes that both the ore and the associated rocks of this series were deposited as sediments, the ore as manganese oxides, and the rocks as clay, marl, and sand. On consolidation and metamorphism the clays were altered to phyllites and mica schists, the marls to crystalline limestones, and the sands to quartzite and quartz schists. Where the manganese ores were pure the metamorphism resulted simply in hardening, and in many places alteration and recrystallization into braunite; but where the ore contained impurities it resulted in the formation of the manganese silicate beds. The crystallized and hardened oxides occurring in the silicates resulted from the excess of ore over impurities, and the presence of other impurities with the manganese silicate is due to the original excess of impurities over manganese oxides.

There are five types of deposits, three of which are of primary and two of secondary origin.

The less metamorphosed Dharwar rocks, in which some of the Balaghat deposits occur, consist principally of slate, phyllite, mica schist, quartzite, quartz schist, and schistose conglomerate. The ores associated with these rocks usually occur as beds and lenses of varying extent. The ore beds are interlayered with the other rocks and are, of course, parallel to them in strike and dip. The ore beds consist of interlaminated manganese oxide and dense, compact black, red, purple, or gray quartzite. The ore is principally hard, dense psilomelane, with associated hollandite and braunite and a very small quantity of pyrolusite. Manganese silicates, such as spessartite, a manganese-aluminum garnet, and rhodonite, the manganese metasilicate, occur along the contact of the ore bed and wall rock, where the maximum metamorphism of the ore bed occurs. In such places braunite, the manganese sesquioxide metasilicate, as would be expected, occurs in relatively larger quantity. The extent of these deposits varies; the largest ones are the Ukua deposits, which have a length of 3 miles and a maximum thickness of about 19

[18] Harder, E. C., op. cit., p. 46.

feet, and the deposit worked in the Balaghat mine, which has a length of 1¾ miles and a maximum thickness of about 45 feet.

In the other deposits of these districts the Dharwar rocks are more highly metamorphosed and consist of quartzite, quartz, mica, and hornblende schists, crystalline limestone, and feldspathic, epidotic, and pyroxenic gneisses. The occurrence of the ore in these rocks is similar to the occurrence in the deposits previously described, though the ore is somewhat more metamorphosed and recrystallized. The lenses and beds are interstratified with the country rock and conform to it in dip and strike. Psilomelane also occurs abundantly in these deposits where the ore was pure originally, and the silicates, braunite, spessartite, and rhodonite occur in much greater proportion than in the less metamorphosed deposits. Where the ore bed originally contained considerable quantities of argillaceous and siliceous impurities locally the entire bed has been altered to manganese silicates, but such extensive alteration is usually confined to the vicinity of the contact between the bed and the wall rock, extending only a short distance into the bed, and the center of the bed consists chiefly of braunite. Quartz is usually an abundant constituent of the beds, and this association has given rise to a variety of rocks, the most common of which are quartz-spessartite, quartz-rhodonite, quartz-spessartite-rhodonite, and spessartite-braunite-rhodonite rock. The quartz-spessartite rock, known as gondite, is typical of the series which is grouped under the name "gondite series." These rocks occur throughout the area in varying width and continuity and are interstratified with the quartzites and crystalline limestones. They show considerable alteration, the degree of which varies with the locality. In some places the alteration, leaching, and subsequent oxidation of the manganese minerals have been so extensive that only small residual quantities of spessartite and rhodonite remain; in other places only veins and pockets of manganese oxides occur in the mass of silicates. The largest body of ore and manganese-silicate rock that occurs in a deposit of this type is known as hill No. 5 of the Ramdongri deposits, in the Nagpur district, which has a length of nearly half a mile and a maximum width of 1,500 feet. There are, however, many deposits in these districts which are several hundred feet in width and several thousand feet long.

The third class of ore deposits comprises bands of nodules and lenticles of brilliantly crystalline manganates, usually hollandite associated with psilomelane and braunite. The lenticles and nodules occur in the crystalline limestone and are generally associated with piedmontite in the Nagpur district and with spessartite and rhodonite in the Chhindwara district. Commonly the silicates occur as a coating or covering on the surface of the nodules, the interior consisting of manganese oxide; some nodules, however, are composed entirely of silicates.

The two remaining groups of deposits have been formed by processes of oxidation. In one the ore is derived from the weathering of the less metamorphosed Dharwar rocks, the resultant manganese oxides being locally concentrated. This ore consists of psilomelane, pyrolusite, and wad. This group of deposits, however, is of little

value. In the other group the ore also consists of psilomelane, pyrolusite, and wad, but is derived from the leaching of gangue from the highly metamorphosed beds of manganese silicates and the subsequent oxidation of the manganese minerals. The secondary ores of this group are of considerable richness and are usually associated with the primary ore of the gondite series.

The following table of analyses indicates the character of the ore from the deposits of the four districts:

Analyses of manganese ore from Central Provinces, India.

	Nagpur.[a]	Chhindwara.[b]	Bhandara.[c]	Balaghat.[d]
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Mn	42.28–55.15	48.95–54.97	49.00–54.07	49.08–54.51
Fe	2.09–16.34	5.00–11.77	4.26–10.25	5.28– 9.10
SiO_2	2.90–18.48	4.98–10.63	2.08– 6.50	1.62– 6.02
P	.04– .65	.06– .28	.06– .34	.05– .24
Moisture	.11– 1.32	.00– 1.27	.09– 1.15	.12– .85

[a] Limits of 26 samples collected in different parts of the district. Fermor, L. L., op. cit., p. 843.
[b] Limits of 8 samples collected in different parts of the district. Fermor, L. L., op. cit., p. 772.
[c] Limits of 13 samples collected in different parts of the district. Fermor, L. L., op. cit., p. 735.
[d] Limits of 13 samples collected in different parts of the district. Fermor, L. L., op. cit., p. 697.

MADRAS PRESIDENCY.

SANDUR HILLS DISTRICT.

The Sandur Hills deposits, in Bellary, are about 300 miles northwest of Madras. They were discovered and developed in 1905 by agents of Messrs. Jambon & Cie., who later transferred their interests to the General Sandur Mining Co. (Ltd.), the present operator.

The rocks in which the manganese ore occurs are of Dharwar age in this district, as in the others previously mentioned. They are somewhat different in character, however, as they consist of chloritic, sericitic, and biotitic phyllites interbedded with contemporaneous basic lava flows and ferruginous quartzite. The iron occurs as magnetite, hematite, and limonite, and the quartzite evidently is similar to the magnetitic and hematite jaspers that occur farther north. The rocks of the district are folded into a closed syncline with a major axis of about 36 miles and a minor axis of about 12 miles. The Sandur Hills represent the outcrops of the Dharwar rocks on the periphery of the syncline and thus inclose a topographic basin. The Bellary plain, which surrounds the Sandur Hills, is underlain by gneiss (pre-Dharwar) and by gneissoid granite and granites of a later period.

The Sandur deposits all occur in the hills on the northern and western sides of the syncline and are divided into four minor districts—Kamataru, Kannevihalli, Kumaraswami, and Ramandrug; the last named was the first developed and is the most productive. The manganese ore, at many places suggesting bedding that corresponds in dip and strike to that of the inclosing rocks, crops out along the ridges and forms a rough, irregular surface devoid of much vegetation. The inclosing rocks consist principally of phyllites and slates, with subordinate quartzite, all of which disintegrate rapidly and leave the outcrops of manganese ore in relief.

The surface indications of the interbedding of the ore with phyllites have not been borne out by development, as all the deposits so far developed do not continue in depth but grade into a banded lithomarge (indurated clay), which is believed by Fermor to be the residual product of the weathering of the phyllite and would indicate that the ore is due to local replacement. However, at the time of Fermor's investigation very few of the deposits had been developed and further explorations may reveal the presence of manganese ore interbedded with the phyllite. The deposits are elongated and tabular and form surface cappings similar to laterite, the larger ones are about 100 feet wide and as much as 700 feet long.

The ore consists principally of wad and psilomelane with small quantities of manganite and pyrolusite. The pyrolusite and manganite occur in the cavities of the irregularly mixed psilomelane and wad ore. Considerable altered phyllite, slate, and magnetite occur in the ore. The average composition of the ore is given as of manganese, 45 per cent; of iron, 12 per cent; of silica, 1 per cent; and of phosphorus, 0.02 per cent. There are about twenty known deposits in the district, which are estimated to contain about 10,000,000 tons of ore.

VIZAGAPATAM DISTRICT.

The Vizagapatam district is also in the Madras Presidency but lies on the east coast of the peninsula about 500 miles southwest of Calcutta. The deposits in this district were among the first in India to be discovered and were the first from which ore was mined. Mining operations were begun in 1891, and the production has steadily increased since that time. The principal operator is the Vizianagram Mining Co. (Ltd.), which has produced more than 90 per cent of the output. Recently the Bobbili Mining Co. and other firms have commenced production. The ore is carted from the mines to Garividi, on the Bengal-Nagpur Railway, a distance of 1 to 8 miles, whence it is shipped to the port of Vizagapatam, a distance of 56 miles. The ore deposits occur in a belt of low plains that border the seacoast and range in width from 30 to 50 miles. The district in which they are found covers about 100 square miles.

The deposits occur in alternating beds of garnetiferous gneissose biotite granite and the khondalite series of metamorphosed sediments. The khondalite series is composed principally of garnet, graphite, quartz, and sillimanite schists. At the contact of the granites and sediments and closely associated with the sediments is a highly gneissose calcareous rock which is composed essentially of calcite, garnet, pyroxene, scapolite, sphene, and wollastonite. The manganese-bearing rocks, known as the kodurite series, are associated with these rocks and particularly with the calcareous gneisses.

The kodurite rocks are variable in composition, but consist principally of potash feldspar, manganese, garnet, and apatite, in places with manganese pyroxene or quartz. They are supposed by Fermor to be of intrusive origin. Several varieties of manganese pyroxene occur. The garnet is of variable composition intermediate between spessartite and andradite. The kodurite rocks that are rich in manganese minerals have been highly altered by surface oxidation, and leaching has left an ore high in manganese oxides.

The principal mines of the district are those of Kodur, Garbham, and Perapi, operated by the Vizianagram Mining Co. (Ltd.), which

together, have made about 90 per cent of the production from the district. The Kodur mines are in a belt of altered manganiferous kodurite rock about 3 miles long and a quarter of a mile broad, in contact on both sides with a diopside-scapolite-wollastonite gneiss, which is inclosed by rocks of the khondalite series in gneissose granite. The surface alteration and leaching of the manganiferous kodurite rock have left manganese ore, lithomarge, yellow ocher, and other alteration products. The alteration and decomposition of the kodurite rock is irregular, masses of fresh rock occurring at various depths in the altered material, and is greatest where the rock was rich in spandite (manganese garnet), feldspar, apatite, and quartz. The manganese ore bodies occur apparently where the rock was rich in spandite, though some enrichment has undoubtedly taken place.

The ore bodies are irregular in size and shape, though usually lenticular, and occur at various intervals along the ore-bearing belt, embedded in lithomarge and other decomposition products, which are locally mixed with the ore. In addition to the large ore bodies, small bands and nodules of manganese ore occur in considerable quantity in the soft altered rocks, particularly in the lithomarge.

Other mines in the district are the Perapi and Garbham, which are very similar geologically to the Kodur mine. The deposit at the Garbham mine is said to be largest in India and is about 4,500 feet long and 167 feet thick. The ore bed, however, contains masses of lithomarge and other decomposition products, which reduce the thickness of the ore proper to about 100 feet. The ore body is cut in its western part by a mass of quartzite or vein quartz. A little unaltered kodurite occurs. The country rock is largely gneissose granite with small quantities of quartz and quartz-garnet rock. At Perapi considerable unaltered rock occurs, principally spandite-feldspar and spandite-rhodonite rock. Chert is associated with cavernous psilomelane and yellow ocher. In the Kodur and Garbham deposits manganese ore has been proved more than 100 feet below the surface.

The principal ore mineral of the district is psilomelane, which is in places cavernous and contains granules of braunite. Braunite is also found in large plates as the predominant mineral. Botryoidal and stalactitic psilomelane and pyrolusite occur in quantity. The ore as mined ranges in manganese content from 35 to 50 per cent, and a large part of it contains considerable iron. Ore containing less than 43 per cent of manganese and more than 15 per cent of iron is classed as ferruginous, and ore containing more than 43 per cent of manganese is classed as manganese ore. The variation in composition of 12 samples of ore is as follows: Manganese, 32.21 to 49.05 per cent; iron, 4.80 to 15.70 per cent; silica, 1.10 to 10.30 per cent; phosphorus, 0.13 to 0.48 per cent; moisture, 0.50 to 1.85 per cent.[19]

BOMBAY.

PANCH MAHALS DISTRICT.

The Panch Mahals deposits, near Sivarajpur, on the Bombay, Baroda & Central India Railway, about 270 miles north of Bombay,

[19] Fermor, L. L., op. cit., p. 1049.

are the principal manganese deposits in the Bombay region. The exploration for manganese began in 1905, and the first shipments were made in 1906 by the Shivrajpur Syndicate (Ltd.) In 1907 the Bamankua Manganese Co. made its first shipment from the district.

The rocks of the district belong to the less metamorphosed phase of the Dharwar series and consist principally of gray siliceous slates, which are in many places calcareous and sericitic, and very fine grained white, purplish, or reddish quartzites, which are locally jasperoid and in places banded with limonite.

The deposits occur in the low hills south and southeast of Sivarajpur, and most of them crop out along the tops of the ridges. The ores are very irregularly distributed and appear for the most part to be the result of replacement of the quartzite and locally of the slate by manganese oxides, though in some places they appear to be distinctly interbedded with the quartzites. The ore bodies are somewhat similar to those of the Sandur district, particularly in the occurrence of small residual masses of the original rocks, which are slate and quartzite in the Panch Mahals district. Development has proved the ore to extend to greater depth than was expected and has furnished some justification for the hope that ore beds occur in addition to the surface replacement deposits. The ore is principally psilomelane, with braunite disseminated through it and in places associated with pyrolusite. The average ore as shipped contains about 52 per cent of manganese; 4 to 6 per cent of silica; and 0.17 per cent of phosphorus.

BENGAL PROVINCE.

GANGPUR DISTRICT.

The Gangpur district is in the Province of Bengal, on the Bengal-Nagpur Railway, about 250 miles west by south of Calcutta. The deposits were discovered in 1907, and production was begun in 1908.

The ore in this district also is associated with the rocks of the Dharwar series, principally mica schists and phyllites, quartzite, and gray dolomite. The ores are interbedded with the schists and quartzite and associated in many places with the manganese-silicate rocks of the gondite series. The rocks and ores and their relations are very similar to those of the deposits in the highly metamorphosed Dharwar rocks of the Nagpur, Bhandara, Balaghat, and Chhindwara districts. The ores consist essentially of psilomelane and braunite in varying proportions.

The deposits at Birbira and Gariajhor are the richest. Those at Gariajhor are the principal ones now being mined; they show seven exposures of ore and manganese-silicate rock along a line about 4,200 feet long, of which the exposure at the southeast end is the largest, and consists of an outcrop about 720 feet long and 10 to 20 feet wide. The country rock consists of interbedded red to gray vitreous quartzite, interbedded in places with the ore, phyllite, and white schist. The ore bed is usually composed of layers of a hard, gray mixture of braunite and psilomelane, with which occur some

wad and small quantities of pyrolusite. The following analyses[20] show the character of the ore:

Analyses of manganese ore from the Gangpur district, Bengal, India.

	Picked specimens.		Average cargo.
Mn	55.35	58.64	51.81
Fe	3.60	1.70	6.38
SiO_2	3.03	1.18	3.52
P	.089	.079	.09

MYSORE STATE.

CHITALDRUG, SHIMOGA, AND TUMKUR DISTRICTS.

The most important manganese districts of Mysore are Chitaldrug, Shimoga, and Tumkur, which are from 130 to 250 miles southeast of Goa and are tributary to the Southern Mahratta Railway. Manganese was first discovered in this State about 1855, but no deposits of commercial importance were found until 1899, when the big deposit at Kunsi, in the Shimoga district, was discovered. After a number of failures to develop the district the New Mysore Manganese Co. (Ltd.) was formed, and this company made its first shipment in 1916. Several other companies soon undertook operations in the district, and production and development have been steady ever since. Production was begun about the same time in the Chitaldrug and Tumkur districts by the Peninsular Minerals Co. of Mysore (Ltd.).

The deposits all occur in the less metamorphosed phase of the Dharwar series and are very similar to those of the Sandur Hills. The Shimoga district is the most productive. It lies in the plains, which are broken by low ranges of hills. The hills are composed of Dharwar rocks, and both the hills and the plains are underlain by granites and gneisses, some intrusive and some of pre-Dharwar age. The deposits are principally in the hilly areas of the Dharwar rocks, which consist of phyllite, slate, dolomite, quartzite, and limestone. The manganese ores occur as cappings on the phyllite or quartzite or their altered equivalents. They are found for the most part on the tops of the hills, and nearly all of them when developed show a gradation in depth from mixed manganese and iron ore to decomposed wad, lithomarge, and quartzite. The deposits appear to have been formed by the surface replacement of decomposed phyllite and quartzite and are very similar to the laterite blankets common to the Dharwar areas. Very few of the deposits continue in depth, and many of them include masses of phyllite and quartzite which here and there are partly replaced by manganese oxides.

The principal minerals are psilomelane, wad, and pyrolusite. The pyrolusite appears to have been formed by the replacement of quartzite, and the wad by a gradual replacement of the lithomarge.

[20] Fermor, L. L., Notes on manganese-ore deposits of Gangpur State, Bengal, and on the distribution of the gondite series in India: India Geol. Survey Rec., vol. 41, pp. 12 et seq., 1911.

The wad grades into the psilomelane. The ore is commonly oolitic and pisolitic in structure, with concentric concretions of psilomelane embedded in a soft material (wad?). The largest deposit of the district is the Kunsi, which is about 1,000 feet long, 320 feet wide, and 50 feet deep and contains a maximum of 300,000 tons of ore.[21] There is considerable variation in the ore from this district, as is shown by the following range in composition: Manganese, 30 to 36 per cent; iron, 2 to 20 per cent; silica, 1 to 6 per cent; phosphorus 0.01 to 0.14 per cent; moisture, about 1 per cent.

The deposits of the Tumkur and Chitaldrug districts are similar geologically to those of Shimoga. The Chitaldrug deposits occur as laterite-like surface replacements by the manganese ore, which consists of a mixture of psilomelane and limonite overlying lithomarge, ocher, and wad. The ores of Tumkur are irregularly scattered through the rocks in which they occur and contain considerable limonite and residual masses of quartzite and argillaceous rock. Much of the ore is ferruginous.

CENTRAL INDIA.

JHABUA DISTRICT.

The Jhabua district, in Central India about 350 miles northeast of Bombay, is at present the least productive manganese district in India and contains only one considerable mine, which is operated by Kiddle, Reeve & Co., who made their first shipments in 1903.

The rocks of the district belong to the less metamorphosed facies of the Dharwar series and are considerably folded. They include chloritic, talcose, and sericitic slate, phyllite, and schist, schistose grit and conglomerate, crystalline limestone and dolomite, and augen gneiss.

The Kajlidongri deposit is the largest and forms a mound about 1,000 yards in length and about 60 or 70 feet above the streams on each side. The ore is intercalated with black and red vitreous quartzite and makes a bed about 20 feet thick. This bed, of which the ore constitutes about 50 per cent, is inclosed by sericite or talc phyllite and is separated from them by a lavender-colored friable sandy rock. The total deposit is estimated at about 800,000 gross tons.

At the north end of the deposit the ore consists of psilomelane with considerable braunite and is associated with an abundance of spessartite and some rhodonite; at the south end it consists of fine-grained psilomelane and braunite, spessartite and rhodonite being absent. From the character of the ore and the association of spessartite and rhodonite it is believed that the north end of the deposit represents an alteration product derived from the original manganese-silicate rock and that the south end was in part originally deposited as manganese oxide interbedded with quartzite and in part formed by a later replacement of the quartzite. The following table

[21] Fermor, L. L., The manganese-ore deposits of India: India Geol. Survey Mem., vol. 37, pts. 1–4, p. 1132.

shows the character of the ore and the differences between the north and south ends of the deposit:

Analyses of manganese ore from the Kajlidongri deposit, Jhabua district, India.

	Southern part.	Northern part.	
Mn	47.77	48.49	48.25
Fe	8.60	10.40	9.45
SiO_2	6.60	8.40	8.60
P	.165	.241	.272

BRAZIL.

Brazil made its first notable production of manganese ore in 1894, and since that time has increased its production so rapidly that it soon became one of the three leading countries. The United States has been the principal consumer of Brazilian ore, and during the war was very largely dependent upon it.

The deposits are reported to occur in the States of Bahia, Minas Geraes, Matto Grosso, Maranhao, Parana, Pernambuco, Rio de Janeiro, Rio Grande do Norte, Santa Catharina, and Sao Paulo.[22] The first three have made the bulk of the production.

MINAS GERAES.

The principal deposits of manganese ore in Minas Geraes are near the stations of Lafayette and Miguel Burnier, on the Central of Brazil Railway, about 283 and 310 miles, respectively, north of Rio de Janeiro. There is some difference of opinion regarding the horizon of these deposits. Harder believes that the deposits occur at two different horizons; Miller and Singewald[23] believe that they do not belong to any definite horizon.

The deposits are of two classes and occur (1) in a complex of granite, gneiss, and crystalline schist, and (2) in metamorphosed sedimentary rocks which overlie the complex and with which are associated the chief iron-ore deposits of Brazil.[24] The deposits of the Lafayette district belong to the first class, and those of the Miguel Burnier district to the second class. The rocks that underlie the portion of Minas Geraes in which the manganese and iron deposits occur have been classified as follows.[25]

Probable Algonkian:

Itacolumi quartzite: Mainly quartzite, but locally containing schists of various kinds, mostly argillaceous.

Piracicaba schist and quartzite: In the lower part mainly schist with lenses of iron formation and carbonate rock; in the upper part containing much quartzite.

Itabira iron formation: A banded hematitic quartzite, known as itabirite, with local beds and lenses of hematite and beds of ferruginous schist.

Batatal schist: Gray and red argillaceous schist.

Caraca quartzite: Quartzite with locally much sericite schist.

Probable Archean:

Gneiss, granite, and schist.

[22] Harder, E. C., Manganese ores of Russia, India, Brazil, and Chile: Am. Inst. Min. Eng. Trans., September, 1916, p. 55.

[23] Miller, B. L., and Singewald, J. T., jr., Mineral deposits of South America, p. 179, 1919.

[24] Harder, E. C., op. cit., p. 787.

[25] Harder, E. C., and Chamberlin, R. T., Geology of central Minas Geraes, Brazil: Jour. Geology, vol. 23, pp. 341–378, 385–424, 1915.

With regard to these deposits Harder[26] says:

The iron ore of Minas Geraes is associated principally with the Itabira iron formation, although a few small deposits occur in iron-formation lenses near the base of the Piracicaba schist. The manganese ore of the first type described above occurs in Archean gneiss, granite, and crystalline schist; those of the second type occur in the upper part of the Itabira iron formation and in the lower part of the Piracicaba schist, being frequently associated with iron ores.

The complex distribution of the various sedimentary rock formations through the central part of Minas Geraes is due in part to irregularity in original deposition, but more especially to extensive folding and faulting, followed by erosion. A profound unconformity separates the sedimentary rocks from the underlying crystalline complex.

In general the metamorphosed sediments extend as a belt of varying width from central and southern Minas Geraes northward and slightly eastward into Bahia. This belt is characterized by a prominent mountain chain, the Serra do Espinhaco, which contains some of the highest peaks and ridges in this part of Brazil. Its prominence is due largely to the superior resistance of weathering of the Caraca quartzite, which is in area by far the most extensive of the metamorphosed sediments. The iron formation generally occurs in well-marked foothills along the sides of the quartzite ridges, though locally, where well developed and especially hard, it itself forms the main ridges, while the quartzite occurs on the slopes. The Piracicaba schist, being soft, is inconspicuous topographically, but the Itacolumi quartzite forms a number of conspicuous peaks and ridges. The mountainous region of metamorphosed sediments is bounded by an irregular, undulating region of hills and valleys, underlain by rocks of the crystalline complex. This is most typically developed east and southeast of the sedimentary belt.

Manganese ores are found in the crystalline complex as large irregular bodies of manganese oxide inclosed in or bounded by gneiss, granite, or crystalline schist. Individual masses, such as that at Morro da Mina, may be several hundred yards in larger diameter. While irregular in shape, they are usually somewhat elongated, suggesting lenses. They occur scattered through the crystalline complex without any apparent regularity, but most of them appear to have either gneiss or crystalline schist on one or both bounding walls.

The manganese oxide composing these lenses is usually in the amorphous form, occurring mainly as psilomelane and wad, though pyrolusite also is found with these. According to detailed studies made by Derby, it appears that these oxides are surface decomposition products resulting from the weathering of other manganese minerals, which in one or two cases, notably in the Piquery mine, have been encountered below the zone of oxidation. Of these minerals the principal ones are tephroite (the manganese olivine) and spessartite (the manganese garnet); and with these occur rhodochrosite (the carbonate of manganese) and sparingly rhodonite (the manganese pyroxene). These minerals are intricately intermixed in varying proportions, one being more abundant in one place and another elsewhere; and together they form a reddish manganese silicate and carbonate rock, in general appearance like quartzite, being hard and dense with platy structure. The relation of the manganese rock to the inclosing crystalline rocks has not been definitely determined; it may be interlayered with the gneiss or crystalline schist, or perhaps intrusive into them.

From the one or two occurrences noted it is judged that all the manganese-oxide deposits in the areas of the crystalline complex are surface-oxidation products of such masses of manganese silicate and carbonate rock. In many of the deposits where the original rock has not been encountered the oxide ores have textures which are duplicated in the manganese silicate and carbonate rock elsewhere and therefore suggest a similar origin for such deposits. In the Morro da Mina mine, where the original rock has not yet been encountered, the massive black ore of the upper levels passes with depth into a lustrous black ore that shows minute isolated specks of spessartite in a groundmass of amorphous manganese oxide (psilomelane). Derby concludes that this groundmass was formed by the alteration of the more readily decomposed tephroite and rhodochrosite, specks of spessartite remaining unaltered.

During the process of decomposition more or less solution and redeposition has taken place, with the result that certain portions of a deposit are composed

[26] Harder, E. C., Manganese ores of Russia, India, Brazil, and Chile: Am. Inst. Min. Eng. Trans., September, 1916, p. 58.

of high-grade manganese oxide, while other portions contain admixtures of other products of decomposition, such as clay and silica. Most of the ore is hard, but soft material, mainly wad and pyrolusite, also occurs in abundance, irregularly intermixed with the hard ore.

The following are average analyses of ore from the Lafayette district.

Analyses of manganese ore from the Lafayette district, Brazil.[a]

	Piquery mine.	São Gonçalo mine.	Morro da Mina mine.
Mn	49.00–51.00	50.00–52.00	50.47
SiO_2	5.00– 7.00	1.00– 2.00	1.76
P	.08– .10	.12– .15	.069
Moisture	3.00– 5.00	3.00– 5.00	2.50
Volatile			[b]12.40
Insoluble residue			3.46
$Fe_2O_3+Al_2O_3$			[c]8.75
S			Absent.

[a] U. S. Geol. Survey Mineral Resources, 1901, p. 142, 1902.
[b] Chiefly oxygen.
[c] Alumina about twice ferric oxide content.

The manganese-ore deposits in the sedimentary series occur as definite beds associated with iron formation. The principal bed, that on which the Wigg mine is situated, is 2 or 3 miles in length and at its maximum reaches a thickness of over 6 feet. It strikes east-west, parallel with the strike of the inclosing sediments, and corresponds with them in dip, making it apparent that the manganese-ore bed was laid down as a sedimentary bed like the inclosing rocks. The bed at the Wigg mine is bounded on one side by soft siliceous iron formation, with a contact zone of mixed soft crystalline hematite and manganese oxide, and on the other side by a ferruginous schist associated with the iron formation. The dip is generally steep, varying on both sides of vertical.

The manganese-ore bed at the Rodeio mine is of smaller longitudinal extent but of greater thickness than that at the Wigg mine and shows less definitely its relation to the inclosing rocks. In the vicinity of both of these deposits beds of carbonate rocks, consisting of a mixture of calcium, magnesium, iron, and manganese carbonates, are found, but at different horizons from the manganese-ore beds.

The manganese ores associated with the sedimentary rocks consist of finely crystalline or amorphous manganese oxides, probably largely a mixture of pyrolusite and psilomelane. From their occurrence it must be assumed that they are similar in origin to the associated rocks—that is, that they are original sedimentary deposits of manganese oxide which have been somewhat altered and recrystallized by subsequent metamorphism. The source of the manganese is doubtful, but it may very well have been derived from deposits of manganese ore in the crystalline complex, such as now occur to the south, near Lafayette. Decomposition of such deposits may have yielded a large amount of residual manganese oxide, which was worked over, transported, and deposited as beds or lenses in the sedimentary series. Their origin would therefore be very similar to that of the iron ores with which they are closely associated.

The ores associated with sedimentary rocks are of somewhat better grade than those occurring in the crystalline complex. The following are typical analyses of the ore:

Analyses of Wigg mine ores.

	Average.[a]	Cargo.[b]
Mn	50.00–54.00	55.14–55.02
SiO_2	1.00– 2.00	.53– 1.25
P	.01– .03	.03– .021
Moisture	15.00–20.00	4.95– 4.74

[a] U. S. Geol. Survey Mineral Resources, 1901, p. 142, 1902.
[b] Scott, H. K., The manganese ores of Brazil: Iron and Steel Inst. Jour., 1900, No. 1, p. 205.

Mining operations were first undertaken in this State in 1894 by Costa & Almeida, who developed the Usina Wigg mine. The discovery of the Wigg ore body was followed by considerable exploration, which soon resulted in the discovery of many deposits in the Lafayette district, notably the Barrosa, Morro da Mina, Piquery, and São Gonçalo. The São Gonçalo mine began production in 1900, the Piquery in 1907, the Morro da Mina in 1904, and the Rodeio, in the Miguel Burnier district, in 1910. The Wigg and the Morro da Mina are steady and large producers. The reserve ore of the two mines is estimated at about 7,000,000 tons.[27] The Morro da Mina mine is one of the most productive manganese mines in the world and is remarkable both for its large size and for the high grade of its ore. It has produced about 2,000,000 tons of ore, and according to a recent estimate by its manager development has proved a reserve of 10,000,000 tons.[28]

Manganese deposits occur in a number of other districts in the State of Minas Geraes, but so far their development has been slight and their output small. However, it is not at all unlikely that a large production will be made from them in the future. Among these districts the Gandarella is particularly promising, and the Barbacena is the next in rank.

BAHIA.

Numerous manganese deposits are known in the State of Bahia, but prospecting and development work have been much less extensive than in Minas Geraes, and only one district has really been developed. This district is about 26 kilometers west of Nazareth, a tidewater town, and about 48 kilometers southwest of Bahia. Three mines, the Sape, Onha, and Pedras Pretas, have been developed, but were more or less idle until 1917. The Sape and Onha mines are connected with the Nazareth Railway by a narrow-gage railway about 5.25 miles long; Pedras Pretas mine is only about half a mile from the Nazareth Railway, and its ore is transported by a gravity railway to the siding. The ore from all three mines is shipped to Nazareth, where it is transshipped to lighters and from them loaded aboard seagoing ships. The cost of the ore aboard is given as about $3 per ton.

The deposits so far developed are situated in a low, hilly, densely forested coastal region which is composed of schists (probably pre-Cambrian[29]) cut by eruptive dikes. The schists are so greatly decomposed that solid rock in place is rarely encountered except in the stream beds. The manganese ore occurs in the soft earthy material that has been derived from the decomposition of the schists and consists principally of psilomelane in lumps and large angular and botryoidal masses. The ore ranges from particles to masses that weigh as much as 1½ tons. The smallest lumps shipped are 2 to 3 inches in diameter.

The ore of the Pedras Pretas mine, which has been the principal producer, occurs in soft earth partly as a horizontal mass very near

[27] Harder, E. C., op. cit., p. 57.
[28] Miller, B. L., and Singewald, J. T., jr., Mineral deposits of South America, p. 184, 1919.
[29] Harder, E. C., op. cit., p. 62.

the surface and partly as a steeply dipping sheet or bed, which ranges from 1 to 30 feet in thickness and connects upward with the horizontal mass. The horizontal mass appears to have been derived from the steeply dipping sheet by the accumulation of the manganese ore during weathering and removal of the surrounding clay. The ore from these mines averages 43 to 49 per cent of manganese, 3 to 4 per cent of silica, 0.016 per cent of phosphorus, and 2 to 3 per cent of moisture.

Several other deposits have recently been opened, but their importance is still problematic.

MATTO GROSSO.

Manganese deposits.—The manganese deposits of Matto Grosso, though extensive, have been little developed. The two deposits that have received most attention are in Morro Urucum and Morro Grande, about 20 kilometers south of Corumbá, not far from Paraguay River.

In 1894 a concession to develop these deposits was granted, but very little work was done, and in 1907 the concession was transferred to the Société anonyme d'Ougrée-Marihaye, a Belgian corporation. In 1918 the concession was reported to have passed to the Companhia Minas e viação de Matto Grosso, an English-American company, which thereby gained the mining rights to an area of 25,000 acres for 30 years.[30] The company has thus far mined about 10,000 tons of ore, but until the completion of a proposed railway from the mines to the port of Ladario, the ore mined will be stored near the mine. The company plans to produce about 15,000 tons annually, after completion of the railway.

Very little has been published about the geology of these two deposits. The best information is a report by Cummings,[31] from which the following notes are taken.

Morro Urucum is a nearly flat-topped butte, whose summit is about 800 meters above the surrounding plain. It consists of nearly horizontal banded siliceous and ferruginous slates containing about 40 per cent of iron. Two beds of manganese ore, conformable with the inclosing strata, crop out about midway between its base and summit, and indications of a third bed are exposed in a tunnel driven at a lower level. Morro Grande consists of similar strata, but only one bed of manganese ore has been found in them. Three tunnels have been driven into Morro Urucum along beds of ore whose average thicknesses are 2, 2.2, and 3.1 meters; but as the tunnels are on different sides of the mountain and the outcrops of the ore bodies can not be followed continuously, it is not certain whether the same or different beds have been explored. Cummings, however, inferred that two continuous beds extended through the mountain and estimated a content of about 15,000,000 tons of ore, much less than is estimated by the mining company.

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[30] Chem. Zeitung, Sept. 14, 1920, p. 686.

[31] Cummings, W. L., quoted in Miller, B. L., and Singewald, J. T., jr., Mineral deposits of South America, pp. 189–190, 1919.

The ores in these beds are firm and hard and vary from brown to black. The following analysis, an average of 15 samples, is quoted from Miller and Singewald:[32]

Average analysis of 15 samples of manganese ore from Urucum Mountain, Matto Grosso, Brazil.

Mn	44.03	CaO	2.30
Fe	13.83	MgO	Trace.
P	.20	Ti	Trace.
SiO_2	1.74	Cu	.006
Al_2O_3	.015	Moisture	2.84

Other analyses show an average content of 45.5 per cent manganese in the two lower beds and 58 to 59 per cent in the upper bed.

No descriptions of other manganese deposits in Matto Grosso are available, but the total ore reserves of the State have been estimated to be about 130,000,000 tons of ore, with an average content of 45.5 per cent manganese.[33]

Taxes.—The Brazilian Federal Government levies no export duties but such taxes are levied by individual States and form a large part of their revenue. In Minas Geraes and Bahia, the principal States that produce manganese, the State collects one tax called the State export tax, and the State and municipality collect another called the industry and profession tax. In addition to these taxes port charges must be paid at the port of shipment.

In Minas Geraes the export tax on manganese ore is based on the official valuation of the product. This valuation is fixed monthly and rarely corresponds exactly with the market value of the ore. The rate for 1919 was fixed at 12 per cent of the official valuation and remained in force until February 21, 1920, when it was reduced to 10 per cent. The following tables[34] indicate the fluctuation in official valuation of the ore and rate of tax for the year 1919 and the first two months of 1920:

Export taxes and expenses on manganese ore in Brazil.

Month.	Official valuation per metric ton.	Fixed ate of export tax (per cent).	Amount of export tax per metric ton.
1919.			
January	$25.00	12	$3.00
February	24.16	12	2.90
March	20.00	12	2.40
April	19.58	12	2.35
May	16.83	12	2.02
June	15.00	12	1.80
July	15.00	12	1.80
August	15.00	12	1.80
September	15.00	12	1.80
October	15.00	12	1.80
November	15.00	12	1.80
December	15.00	12	1.80
1920.			
January	15.00	12	1.80
February	12.50	10	1.25

[32] Op. cit., p. 190.
[33] Chem. Zeitung, Sept. 14, 1920, p. 686.
[34] A. T. Haeberle, American consul general, Rio de Janeiro, Brazil, Apr. 15, 1920.

The Estrada de Ferro Central do Brazil, the railway which serves the manganese mines, has four different freight schedules applicable to the transfer of ore from the mine to the seaport. The tariffs, per wagon load and kilometer-ton, are shown below. They vary according to the price in Rio de Janeiro as follows: Tariff 3–I, when price is $20 or more; 3–K, from $17.50 to $20; 3–L, from $15 to $17.50; 3–M, below $15.

Railway tariffs on manganese ore, in cents, United States currency.

Distance (kilometers).	3–I.	3–K.	3–L.	3–M.
000–100	1.5500	1.3000	1.1750	1.0500
101–200	1.4750	1.2500	1.1375	1.0250
201–300	1.4000	1.2000	1.1000	1.0000
301–400	1.3250	1.1500	1.0625	.9750
401–500	1.2500	1.1000	1.0250	.9500
501–600	1.1750	1.0500	.9875	.9250
601–700	1.1000	1.0000	.9500	.9000
701–800	1.0250	.9500	.9125	.8750
801–900	.9500	.9000	.8750	.8500
901 and more	.8750	.8500	.8375	.8250

The valuation of the ore affixed by the railway company is based upon the price of the ore at Rio de Janeiro and does not correspond to the official valuation of the ore affixed by the State of Minas Geraes. As all the ore produced by the State at present is shipped through the port of Rio de Janeiro, an additional tax of 3 francs per metric ton of manganese is charged in addition to the regular port tax. This additional tax was reduced in February, 1920, to 2 francs and will remain at this reduced rate until the value of the ore rises above $12.50 per metric ton in Rio de Janeiro. At present it amounts to about 7 cents per metric ton. No definite figures on the industry and profession tax can be obtained, as each firm is charged separately and differently. The difference in taxation applies to the industry and profession tax levied on the exporter by the municipality of Rio de Janeiro and also on the same tax levied by the State of Minas Geraes and in the different municipalities in which manganese is produced.

The State of Bahia charges an export tax based upon the official value of a metric ton of ore. The following table indicates the tax collected from January, 1918, to March, 1920:

Export taxes collected in Bahia on manganese ore.

	Official value per ton.	Rate of export tax (per cent).	Export tax per ton.
Jan. 3 to Feb. 16, 1918	$5.00	8.7	$0.4350
Feb. 17 to June 16, 1918	12.50	8.7	1.0875
June 17, 1918, to Jan. 13, 1919	20.00	8.7	1.7400
Jan. 14 to Feb. 13, 1919	17.50	8.7	1.5225
Feb. 14 to 27, 1919	12.50	8.7	1.0875
Feb. 28 to Apr. 13, 1919	12.50	8.7	1.0875
Apr. 14 to Dec. 31, 1919	10.75	8.7	.9352
Jan. 1 to Feb. 29, 1920	8.75	9.2	.8050

Most of the ore is transported by the Chemins de fer fédéraux de l'est brésilien, which charges a tariff of $6.70 per metric ton of ore from Bomfin to the port of Bahia, a distance of 445 kilometers, and $6.82½ per metric ton from Missão to the port of Bahia, a distance of 457 kilometers. The port taxes in Bahia amount to $1.62½ per metric ton. The industry and profession tax in Bahia, as in Minas Geraes, varies with the different firms. In 1918 and 1919 the taxes were as follows:

Industry and profession taxes on manganese ore in Bahia.

Municipality.	1918	1919
Nazareth	$112.50	[a] $112.50
Bomfin	133.75	[a] 133.75
Bahia City	3,284.50	[a] 2,713.50
State tax of Bahia	3,712.50	[a] 4,400.00

[a] Plus 12½ cents per metric ton shipped.

Future output.—Although the mining of manganese has been considerably curtailed since the war and many mines, particularly those in the State of Bahia, are closed for the present, there is no doubt that Brazil will furnish a very large part of the manganese consumed in the United States. With the continued control of the Russian manganese deposits by the soviet and the rather high freight rates on manganese ore from India, the United States is more than ever dependent upon the Brazilian deposits.

It is apparent that the Brazilian deposits have hardly more than entered their productive stage and appear to be of a character and extent to supply both the high-grade and low-grade manganese required by the United States for an almost indefinite period. The increasing interest of Americans in Brazilian manganese deposits in recent years is insuring an appreciable measure of commercial control which should make the American steel producer more or less independent of other foreign sources for the manganese required in the industry. The improvement in transportation facilities and the attitude of the Brazilian Government in granting concessions are rapidly making available tremendous quantities of high-grade ore which until very recently were not considered of commercial value.

CHILE.

Manganese ores were extensively mined in Chile for about 15 years before the end of the last century, and during that time about half a million tons was exported, most of it to the United States. The industry, however, suffered from lack of proper development, inadequate transportation, and the relatively high cost of labor, and early in the present century the richer and more cheaply mined Indian ores displaced the Chilean ores in the market. Since 1905 little or no manganese ore has been mined in Chile. Many of the mines have been abandoned, and most of the surface equipment has been neglected and ruined.

The deposits, however, are by no means exhausted,[35] and, although it is impossible to forecast their future, there is little doubt that at

[35] Harder, E. C., Manganese ores of Russia, India, Brazil, and Chile: Am. Inst. Min. Eng. Trans., September, 1916, p. 63.

some time the Chilean manganese mining industry will again be of considerable importance. In fact, the present development of the Chilean iron-ore deposits may react very favorably on the manganese industry.

MINING DISTRICTS.

According to Harder, the manganese ores of Chile occur in the Huasco and Carrizal districts, in the Province of Atacama; the Los Chorros, Las Cañas, La Liga, Arrayan, and Corral Quemada districts, in the Province of Coquimbo; and the Aculeo district, in the Province of Santiago. The principal output has been derived from the Carrizal and Corral Quemada districts. Considerable ore has been shipped from the Las Cañas and La Liga districts. According to Harder, the Chilean manganese ore deposits may be grouped in three distinct classes according to their geologic occurrence—(1) ores occurring interbedded with jasper and chert in a limestone-chert formation; (2) ores occurring interbedded with red sandstone, shale, and limestone which are interbedded with massive volcanic flows; and (3) ores occurring as veins in effusive volcanic rocks. The ores of Huasco and Carrizal belong to the first class, those of Las Cañas, La Liga, Arrayan, and Corral Quemada to the second class, and those of Aculeo and Los Chorros to the third class. The sediments and igneous rocks with which the ores are associated are all of Mesozoic age. The following short descriptions of the principal districts are based largely on Harder's paper.[36]

The Carrizal district lies between Huasco and Carrizal, about 350 miles north of Valparaiso, in a rugged, barren part of the coast mountains. In this district the ore occurs in a belt which is continuous in the northern part and runs approximately north and south. In the northern part of the belt, which is several miles in extent, there are several abandoned mines that were large producers. This part of the belt contains from one to three beds of manganese ore, usually separated by a few feet of jasper or chert. Although these beds are generally continuous, they pinch out locally, and new ones appear. They conform in dip and strike to that of the inclosing rocks, which consist principally of interbedded gray chert and gray limestone of varying thickness. The dip ranges from 60° E. to almost 90°. The ore beds range in thickness from less than a foot to about 5 feet and are generally inclosed by a pink or dark-red jasper which extends several yards from the contact, the ore ultimately giving place to the gray chert. The jasper contains many veins of crystalline hematite, which accounts for its color. Sills of dark-green basic igneous rocks which are in places comparatively wide but rarely of any great length occur here and there.

The ore is for the most part a dense, hard black psilomelane with conchoidal fracture. Much of it contains silica in the form of chert, which is so stained with manganese oxide as to be hardly distinguishable from the ore itself.

The southern part of this belt is comparatively short but contains two mines that have been large producers. Its continuity is broken

[36] Op. cit., p. 795.

in several places. The more productive part of the belt contains four parallel ore beds, which strike approximately northeast and dip about 45° NW. The principal country rock is gray limestone, locally crystalline, which is interbedded with gray or white chert. At some distance below the level of the ore beds lies a thick sill of green basic rock. The ore beds themselves are inclosed in a narrow casing of banded red jasper which extends only a few feet from the ore contact. The ore is principally a hard bluish-black braunite with subordinate amounts of psilomelane and some undetermined soft black oxides.

The following analyses indicate the grade and character of the ore from the Carrizal district:

Analyses of manganese ore from the Carrizal district, Chile.

	Coquimbana.	Huasquina.
Mn	45.82	37.08
Fe	2.74	3.21
SiO_2	5.42	11.97
P	.093	.116
H_2O (combined)	3.78	3.48

The Las Cañas, La Liga, Arrayan, and Corral Quemada districts, in the western foothills of the Andes Mountains, lie in a generally north-south zone and are separated from each other by barren areas.

The Las Cañas district, which is in the northern part of this area, is about 25 miles east of La Serena; the Corral Quemada district, which is in the southern part of the area, is northeast of Ovalle. The other two districts lie between the two mentioned. These districts all contain many old workings, but the principal operations have been confined to the Las Cañas and Corral Quemada districts. In the former district the Potosi, one of the larger mines, was worked by both the underground and open-cut methods.

The foothills of the Andes in this area are composed very largely of effusive trachyte and related volcanic rocks which have a prevailing dark-red or purple color. There are in the area, however, a number of other effusive volcanic rocks which have not been classified. The sedimentary rocks containing the manganese ore are interbedded with these flows and though in places of considerable extent more commonly cover rather small areas. The sedimentary rocks consist almost entirely of red and pink sandstone, shale, and limestone, with small amounts of jasper, and vary in thickness from a few feet to 50 feet. A few thin beds of volcanic rock are interbedded with them.

According to Harder, manganese ores are interbedded with the sedimentary rocks and occur in one, two, or three parallel beds, which are generally within a few feet of one another. They are as a rule closely associated with a limestone. In places the ore bed may consist of equal quantities of intermixed limestone and ore. A great part of the limestone is stained black by manganese oxide.

The ore beds may occur at any level in the sedimentary series. In some places they overlie and in others they underlie the trachytic flows; and in still others they lie at various levels well removed from

any trachyte, entirely within the sedimentary series. The ore beds range in thickness from a fraction of an inch to 4½ feet and consist principally of pure granular to finely crystalline bluish-gray or bluish-black pyrolusite, which is usually compact but rather soft.

The following analyses indicate the character of the ore from these districts:

Analyses of manganese ore from the Province of Coquimbo, Chile.

	Mina Alta, Las Cañas.	Mina Potosi, Las Cañas.	Mina Estrella, La Liga.	Elsie cut, Corral Quemada.
Mn	40.31	52.85	49.54	50.00
Fe	3.38	1.09	1.29	.78
SiO_2	11.20	7.74	5.00	9.43
P	.022	.007	.010	.013
H_2O (combined)	1.15	.90	1.00	1.18

Very little is known of the reserves in these districts, but Harder, after visiting all the districts, lays considerable emphasis on the stratigraphic relations of the ore deposits and believes that with proper development large quantities of ore may be proved in most of the districts.

URUGUAY.

The manganese deposits of Uruguay are mentioned here on account of their extent rather than on account of their present commercial importance. The following description is taken from the Commerce Reports, January 8, 1919. The quantity and analyses given agree with the estimates made by Rolf Marstrander.[37]

Pockets and traces of manganese are found in practically all parts of Uruguay. Many small and some large deposits of ore have been examined or are known to the Bureau of Geology, and drillings are mentioned in a report on the mineral resources of the country, published in 1916.

Most of the deposits are too small or too poor in quality to make exploitation worth while. In other places lack of transportation facilities and timber stand in the way of successful operation.

One of the principal deposits is found in the Department of Rivera, near Arroyo Zapucay. There are two hills made up almost entirely of ore, and it is estimated that 80,000,000 tons could be taken out by open cuts. The deposit is covered by nine concessions extending over 22,000 acres and is the property of the Uruguay Manganese Co. The analysis shows an average content of 34.8 per cent of iron, 22.7 per cent of manganese, 9 per cent of silica, 0.03 per cent of phosphorus, and 0.05 per cent of sulphur. The Uruguay Manganese Co. was formed at Montevideo several years ago, and the stock was subscribed largely by English investors. It was planned to build a 75-mile branch of the Central Uruguay Railroad to the deposit, and the venture aroused much interest. Very little

[37] Ministerio de Industrias, Instituto de geología y perforaciones, Bol. 2, p. 9, Montevideo, 1915.

development work has been done, however, and the deposit is not being worked. There are at present no transportation facilities, and the necessary fuel and timber for producing ferromanganese are lacking.

The same difficulties stand in the way of working a similar manganese (?) deposit at Caraguata, in the Department of Tacuarembo.

There are a number of small deposits of manganese in other departments and, as stated above, pockets and traces of the ore occur practically all over the country. One of these is located at Carrasco, 9 miles east of Montevideo, on the coast. It has been examined by representatives of British and German interests and is being worked at present on a small scale, the ore being used by glass factories. The outcrops are small and scattered, and the deposit appears to extend 500 to 650 feet from north to south and to have a width of 165 feet. The ore is stated to contain 30 to 40 per cent of manganese.

So far as is known, the only manganese deposit in Uruguay that is being worked on any considerable scale at present is a 16-foot vein composed of small stringers at the Pantanoso, in the immediate vicinity of Montevideo. The owners, who are Argentines, claim to have invested about $100,000. Ore is being extracted at a depth of 90 feet. Most of the ore is hand picked. The operators exported to Argentina for use in glass factories some 16 tons of manganese ore from January to August, 1918, and the local representatives of the owners recently obtained an export permit for 100 tons of ore, which is not, however, ready for shipment. Official statistics show that Uruguay exported 2 tons of manganese ore in 1915, none in 1916, and 1 ton in 1917.

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QUICKSILVER.

By F. L. Ransome.

STATISTICAL SUMMARY.

Quicksilver produced in the United States in 1919.

State.	Ore treated (short tons).	Percentage (tenor won).	Quantity (flasks of 75 pounds).	Value.
California	138,019	0.41	15,205	$1,372,859
Texas	38,864	.48	5,019	453,166
Nevada	[a] 6,630	.43	756	68,259
Oregon	[a] 5,160	.32	435	39,276
	188,673	.42	21,415	1,933,560

[a] Estimated

Average price per flask:

San Francisco	$90.29
New York	$92.15
London	£20 9s. 5½d
Total number of mines producing	34
Total decrease of production in 1919 from 1918—flasks	11,468
Total exports from United States (9,107 flasks)—pounds	683,004
Total imports into United States (10,635 flasks)—pounds	797,613

INTRODUCTION.

The decline in mining activity and in the production of quicksilver, already marked in 1918, was still more plainly evident in 1919. The prices obtainable in 1919 were decidedly lower than in 1918 and fluctuated between $72 and $104 a flask. As the average price in December was $95 and in March $72.80, it can not be said that the movement was progressively downward. The excess of imports over exports of quicksilver was 3,621 flasks in 1918, but only 1,528 flasks in 1919. Consequently the influx of foreign quicksilver can hardly be regarded as at present a very important factor in the depression of the domestic industry. The apparent consumption of quicksilver in the United States fell from 36,504 flasks in 1918 to 22,943 flasks in 1919, or approximately to the pre-war consumption. The domestic quicksilver producer in 1919 operated under the disadvantages (1) of a lessened demand for his product, (2) of a price for the metal that, although high as compared with prices before the war, was low in comparison with the current cost of production, and, finally, (3) of an increasing difficulty in finding ore of such grade and in such quantity as to give him a margin of profit wide enough to permit continuous operation under ordinary fluctuations in prices and costs.

The Geological Survey report on quicksilver in 1917, which may still be had upon application, contains much information, par-

ticularly concerning foreign occurrences, the mineralogy of quicksilver ores, and the costs of producing quicksilver, that has not been repeated in the present report. It also contains a bibliography of quicksilver in North America. The report for 1918, also obtainable, contains a descriptive list of the quicksilver mines in the United States.

PRODUCTION.

WORLD'S PRODUCTION.

In the following table are given the best figures available for the world's production of quicksilver in recent years. The foreign figures, generally published in metric tons, are calculated to flasks of 75 pounds net by multiplying by the factor 29.395. So far as possible the figures are taken from official statistical publications of the respective countries. Where no trustworthy official data were obtainable the output has been estimated on such miscellaneous information as could be collected. For Austria and Hungary no official statistics have been obtainable since the outbreak of the World War. Until more definite information is available, it has seemed best to make no changes in the names of European countries as they appear in the table. The estimate of production for "Mexico and other countries" is admittedly based upon very meager data. Mexico is reported [1] to have produced about 33 metric tons, or 970 flasks, in 1917, and 164 metric tons, or 4,821 flasks, in 1918. Algeria produced 18 metric tons, or 529 flasks, in 1917, and 10.4 metric tons, or 306 flasks, in 1918.[2]

Peru yielded only 1.5 metric tons, or 44 flasks, in 1918.[3]

World's production of quicksilver, 1910–1918, in flasks of 75 pounds.

[1 metric ton=29.395 flasks.]

Country.	1910	1911	1912	1913	1914	1915	1916	1917	1918
United States	20,601	21,256	25,064	20,213	16,548	21,033	29,932	36,159	32,883
Austria	*a* 17,725	*a* 20,694	*a* 22,428	*a* 24,104	*b* 25,000	*b* 25,000	*b* 25,000	*b* 25,000	*c* 17,637
Hungary	*d* 2,641	*d* 2,339	*d* 2,494	*d* 2,606	*b* 2,500	*b* 2,500	*b* 2,500	*b* 2,500	*b* 2,000
Italy	*e* 26,264	*e* 28,072	*e* 29,406	*e* 29,513	*e* 31,541	*e* 28,954	*f* 32,129	*e* 31,494	*e* 30,512
Russia	*g* 118	.....	.....	.....	.....	*h* 800	*h* 1,100	*b* 500	.....
Spain *i*	32,892	43,912	36,921	36,619	28,000	35,925	23,369	25,147	16,677
Mexico and other countries *b*	4,500	4,500	4,500	4,000	4,000	4,000	4,000	4,000	5,500
	104,741	120,773	120,813	117,055	107,589	118,212	118,030	124,800	105,209

a Statistik des Bergbaues in Österreich, Wien.
b Statistics not available. Estimate only.
c Estimate by "the Italian bureau of mines." Dennis, A. P., Commerce Repts., No. 43, p. 1040, 1920.
d Ungar. statist. Jahrb., Budapest.
e Riv. servizio min., Roma.
f Min. Jour., London.
g Metallgesellschaft, Frankfurt-am-Main.
h Statistics not available. Estimate based on oral information from Russian Special Commission to United States in 1917.
i Estadística minera de España, Madrid.

The most noticeable features brought out by comparison of the world's production in 1918 with that in 1917 is the decided falling off in output of the leading quicksilver-producing countries. This is particularly true with respect to Spain, where the output, notwith-

[1] The Metal Industry, vol. 18, p. 232, 1920.
[2] Statistique de l'industrie minérale, Paris, 1919, p. 127.
[3] Revista minera, met. y de ing., Madrid, May 16, 1919, p. 239.

standing the comparatively high price of quicksilver, dropped from 25,147 to 16,677 flasks, a decrease due mainly, of course, to the surprisingly small output from the Almaden mine. (See p. 175.)

DOMESTIC PRODUCTION.

Including some small prospects that yielded less than 5 flasks each, there were 34 productive quicksilver mines in the United States in 1919, against 47 in 1918 and 51 in 1917. This number includes at least two important mines at which dumps and ground under old reduction works contributed a considerable part of the total output. Of the productive mines, 20 are in California, 6 in Nevada, 5 in Texas, and 3 in Oregon. Less than half of these mines were productive during the entire year, and at least a fourth of them closed down with little prospect of an early resumption of activity.

According to reports to the Geological Survey from individual mine operators, the output of quicksilver in the United States in 1919 was 21,415 flasks of 75 pounds each, against 32,883 flasks in 1918 and 36,159 flasks in 1917.

At the average price for the year, $90.29 a flask, based on quotations for domestic quicksilver in San Francisco published weekly in the Mining and Scientific Press, the value of the output in 1919 was $1,933,560, a decrease of $1,930,192 from 1918. In other words, in consequence of lessened production and lower prices for quicksilver, the total value of the metal produced in 1919 was only about half of that produced in 1918. The producers of 17,527 of the 21,415 flasks stated on their statistical reports the value of their product. On the supposition that this was in general the amount received from sales, it corresponds to an average value of $85.47 a flask, or $4.82 less than the average quotation in San Francisco—an unusually large discrepancy.

Quicksilver produced in the United States, 1914–1919, in flasks of 75 pounds.

State.	1914		1915		1916	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona					5	$629
Oregon [a]	3,156	$154,801	4,423	$379,493	[b] 378	47,587
Texas					6,306	793,862
California	11,303	554,414	14,283	1,225,481	21,045	2,649,355
Nevada	2,089	102,465	2,327	199,657	2,198	276,706
	16,548	811,680	21,033	1,804,631	29,932	3,768,139

State.	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Arizona	40	$4,213	.....	.....	.....	.....
Oregon	388	40,864	702	$82,485	435	$39,276
Texas	10,791	1,136,508	8,451	992,992	5,019	453,166
California	23,938	2,521,151	22,664	2,663,020	15,205	1,372,859
Nevada	997	105,004	1,044	122,670	756	68,259
Idaho	5	526	22	2,585	.....	.....
	36,159	3,808,266	32,883	3,863,752	21,415	1,933,560

[a] Oregon had no output in 1914.

[b] Includes 75 flasks from Washington.

The following table gives the quantity, average price, and value of the quicksilver produced annually in the United States from the year 1850:

Quicksilver produced in the United States, 1850–1919.

[In flasks of 76.5 pounds to June, 1904; subsequently in flasks of 75 pounds.]

Year.	Flasks.	Value per flask.	Value.	Year.	Flasks.	Value per flask.	Value.
1850	7,723	$99.45	$768,052	1886	29,981	$35.50	$1,064,325
1851	27,779	66.93	1,859,248	1887	33,825	42.375	1,433,334
1852	20,000	58.33	1,166,600	1888	33,250	42.50	1,370,625
1853	22,284	55.45	1,235,648	1889	26,484	45.00	1,191,780
1854	30,004	55.45	1,663,722	1890	22,926	52.50	1,203,615
1855	33,000	53.55	1,767,150	1891	22,904	45.25	1,036,406
1856	30,000	51.65	1,549,500	1892	27,993	40.71	1,139,595
1857	28,204	48.73	1,374,381	1893	30,164	36.75	1,108,527
1858	31,000	47.83	1,482,730	1894	30,416	30.70	933,771
1859	13,000	63.13	820,690	1895	36,067	37.04	1,335,922
1860	10,000	53.55	535,500	1896	30,765	34.96	1,075,544
1861	35,000	42.05	1,471,750	1897	26,691	37.28	995,040
1862	42,000	36.35	1,526,700	1898	31,092	38.23	1,188,647
1863	40,531	42.08	1,705,544	1899	30,454	47.70	1,452,656
1864	47,489	45.90	2,179,745	1900	28,317	44.94	1,272,566
1865	53,000	45.90	2,432,700	1901	29,727	48.46	1,440,570
1866	46,550	53.13	2,473,202	1902	34,291	43.20	1,481,371
1867	47,000	45.90	2,157,300	1903	35,634	45.29	1,613,864
1868	47,728	45.90	2,190,715	1904	35,315	43.50	1,536,203
1869	33,811	45.90	1,551,925	1905	30,534	36.22	1,105,941
1870	30,077	57.38	1,725,818	1906	26,083	39.50	1,030,279
1871	31,686	63.10	1,999,387	1907	21,554	39.60	853,538
1872	31,621	65.93	2,084,773	1908	19,752	44.17	872,446
1873	27,642	80.33	2,220,482	1909	21,075	45.45	957,859
1874	27,756	105.18	2,919,376	1910	20,601	46.51	958,153
1875	50,250	84.15	4,228,538	1911	21,256	46.01	977,989
1876	72,716	44.00	3,199,504	1912	25,064	42.05	1,053,941
1877	79,395	37.30	2,961,434	1913	20,213	40.23	813,171
1878	63,880	32.90	2,101,652	1914	16,548	49.05	811,680
1879	73,684	29.85	2,199,467	1915	21,033	85.80	1,804,631
1880	59,926	31.00	1,857,706	1916	29,932	125.89	3,768,139
1881	60,851	29.83	1,815,185	1917	36,159	105.32	3,808,266
1882	52,732	28.23	1,488,624	1918	32,883	117.50	3,863,752
1883	46,725	28.75	1,343,344	1919	21,415	90.29	1,933,560
1884	31,913	30.50	973,347				
1885	32,073	30.75	986,245		2,359,428	.....	114,505,390

The quantity and value of the quicksilver produced annually in the United States are also shown graphically in figure 4.

QUANTITY AND TENOR OF ORE MINED AND TREATED.

Statistics of ore mined in 1919 are very unsatisfactory. The returns from the larger mines in California and Texas are fairly complete and estimates had to be resorted to only for a few of the smaller producers. In Oregon and Nevada, however, operations were desultory and discontinuous, and only one producer appears to have kept any record of the quantity of ore mined or treated. For these two States it has been necessary to estimate from the quicksilver produced the probable quantity of ore mined and treated, it being assumed in the calculation that the ore worked was of the same grade as that mined in 1918.

The total quantity of quicksilver ore mined in the United States in 1919, in part estimated as explained above, appears to have been about 196,418 short tons. This includes 10,351 tons of material excavated from the site of old reduction works at New Almaden and an unknown quantity of old dump material that was treated at New Idria with newly mined ore. Operations at Sulphur Bank ceased

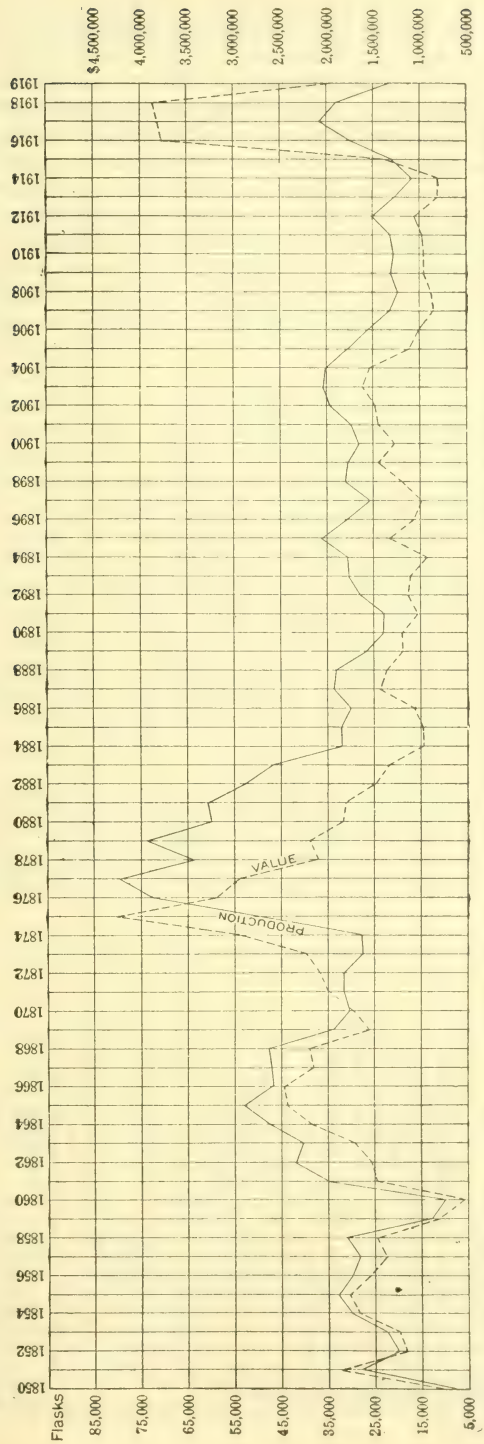

FIGURE 4.—Diagram showing quantity and value of quicksilver produced in the United States from 1850 to 1919, inclusive.

so early in the year that the quantity of dump material there excavated by steam shoveling was practically negligible. It is estimated that there was treated in furnaces 173,982 short tons of ore, which yielded 19,887 flasks of quicksilver. This was at the rate of 0.43 per cent, or 8.6 pounds of quicksilver to the ton of ore, whereas in 1918 the average yield of furnace ore was 0.37 per cent, or 7.4 pounds to the ton. The average in 1919 compares closely with that for 1917, which was 0.46 per cent. There was treated in retorts 4,320 tons of ore, which yielded 841 flasks of quicksilver; this was at the rate of 0.73 per cent, or 14.6 pounds of quicksilver to the ton of ore, as compared with 0.81 per cent, or 16.2 pounds to the ton, in 1918. At New Almaden 10,351 tons of earth from the site of old furnaces and condensers yielded by washing 685 flasks of quicksilver, and 2 additional flasks of native quicksilver was obtained by hand washing elsewhere in California.

The fact that the ore treated in furnaces in 1919 averaged a little higher in grade than that treated in 1918 would be encouraging if it were not necessary to consider this slight increase in average tenor in connection with the much more significant decrease in production. It then becomes evident that the average has gone up not because the available ore in the mines has become richer or more abundant but because certain mines that had been operated with difficulty on very low grade ore have dropped out of the ranks of the producers. A notable example is the Sulphur Bank mine, where in 1918 about 87,500 tons of dump material that averaged only about 0.03 per cent of quicksilver was handled. Other mines, of less unusual character, at which operations ceased in 1919 because the visible supply of quicksilver-bearing material could not be worked at a profit—in other words, was not ore—are the Black Butte, in Oregon, and the Culver-Baer, Great Eastern, and Aetna, in California.

In the following table, which shows quicksilver ore treated and metal won in the United States, a notable feature is the marked decrease in the tenor of ore worked in Texas. The increase shown in the tenor of ore worked in California has already been commented upon.

Quicksilver ore treated and metal won in the United States, 1916–1919.

State.	1916			1917			1918			1919		
	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.	Ore treated (short tons).	Metal won (pounds per ton).	Percentage tenor won.
Arizona	2			79	38.0	1.90						
Oregon	[a] 5,802	4.8	0.24	12,732	[b] 2.3	[b] .11	13,034	4.0	0.20	[c] 5,160	6.4	0.32
Texas	25,945	18.2	.91	28,242	28.4	1.42	36,482	17.4	.87	38,864	9.6	.48
California	205,072	7.6	.38	235,786	7.6	.38	355,000	4.8	.24	138,019	8.2	.41
Nevada	12,911	12.6	.63	3,639	20.4	1.02	11,078	7.0	.35	[c] 6,630	8.6	.43
Idaho				6	62.4	3.12	60	27.4	1.37			
	249,732	9.0	.45	280,484	9.6	.48	415,654	6.0	.30	188,673	8.4	.42

[a] Includes 47 tons from Washington.
[b] These figures abnormally low, owing to accumulation of unworked soot.
[c] Estimated.

The table below shows the relative importance of furnaces and retorts in the production of domestic quicksilver. The furnaces are preponderantly fine-ore inclined-tile furnaces of the Hüttner-Scott type, but include some coarse-ore shaft furnaces of simple construction and a few exception models. The retorts are chiefly of the cylindrical pipe form, usually arranged in "banks" or "benches" of 12 retorts, but include also a number of the D pattern and a few unusual varieties.

It is noteworthy that in Texas the ore worked in retorts was apparently of lower grade than that treated in furnaces. The retorts, however, were run for only a part of the year. Unfortunately, for the reason previously stated, no great reliance can be placed on the data assembled in the table under "Other States."

Quicksilver ore treated in furnaces and retorts in 1919.[a]

State.	Ore treated (short tons).		Quicksilver won (flasks).		Percentage tenor won.	
	Furnaces.	Retorts.	Furnaces.	Retorts.	Furnaces.	Retorts.
California	126,498	1,150	14,335	183	0.42	0.59
Texas	37,784	1,080	4,918	101	.49	.35
Other States[b]	9,700	2,090	634	557	.25	.99
	173,982	4,320	19,887	841	.43	.73

[a] In addition, in California 10,371 tons of material carrying quicksilver in the metallic state was treated by washing and yielded 687 flasks.
[b] Includes Oregon and Nevada. Figures of quantity estimated.

METHODS OF PRODUCTION.

The volume on "The quicksilver resources of California," by W. W. Bradley, published in 1918 as Bulletin 78 of the California State Mining Bureau, treats extensively of the metallurgy of quicksilver ores and should be consulted by those interested in this subject. The results of the investigations of the United States Bureau of Mines, referred to in the report for 1917, have also appeared in part as Technical Paper 96, "Fume and other losses in condensing quicksilver from furnace gases," by L. H. Duschak and C. N. Shuette, published in 1919.

The ores of quicksilver, unlike those of most metals that are won by smelting, are without exception in this country treated at the mines, and the liquid metal is shipped as a finished commercial product. A moderate heat, about 360° C., is sufficient to vaporize and decompose cinnabar, and metallic quicksilver is readily obtained by condensation. In outline the process is exceedingly simple, but in practice it is by no means easy so to control the operation as to obtain practically all of the metal from the ore with the minimum expenditure of labor and fuel.

In general, two classes of reducing plants may be distinguished, namely, furnaces and retorts. In the furnaces, with the exception of the Fitzgerald furnace and the Livingston retort furnace, which are little used, the ore is exposed to the direct action of the flame and the volatile products of combustion, with more or less dust, as well

as the mercury vapor, are drawn into the condensing chambers. In retorts, on the other hand, the ore is heated in a closed vessel, out of contact with the flame, and only those volatile constituents that are driven off from the charge pass into the condensers. Furnaces are comparatively expensive, but have greater capacity than retorts, cost much less to operate per ton of ore, and, for ores of medium and low grade, are more efficient. Retorts, on the other hand, are comparatively cheap and can be successfully employed in treating small bodies of rich ore, although their use is attended with the ever-present danger of salivation or mercurial poisoning. The relative importance of the two classes of reduction plants may be seen from the table on page 155.

The standard furnace in the United States is the Hüttner-Scott, or, as it is commonly called, the Scott furnace. This is a masonry structure of rectangular shaft form and requires special skill in its construction. The ore is fed at the top and falls over a series of alternating or "staggered" fire-brick shelves inclined at 45°. The rate of passage through the furnace is controlled by drawing off portions of the spent charges at regular intervals from the bottom of the shaft, and the burning is continuous. The flames pass back and forth through the flues formed by the spaces that the ore does not fill under the sloping shelves. The shelves are arranged in one to five vertical compartments, according to the size of the furnace. The fuel is wood or oil and is burned in one or more fire boxes, not mixed with the ore.

Rotary furnaces, such as were described in the report on the production of quicksilver in 1917, were in successful operation at the New Idria and at the Cloverdale mine, both in California. Whether the similar furnace at the Chisos mine, in Texas, was in steady operation is not known.

A log washer continued to be effectively employed at New Almaden to recover quicksilver from material excavated from the site of old furnaces and condensers.

PRICES.

The average domestic price of quicksilver was lower in 1919 than for any other year since 1915, and, although it was more than double the prices that prevailed before the war, this apparent advantage to the producer was fully offset by the high prices of supplies and the scarcity and general inefficiency of labor.

The prices given in the following table for the United States and the United Kingdom have been obtained by averaging the weekly quotations published in the Mining Journal for London; the Engineering and Mining Journal, for New York; and the Mining and Scientific Press, for San Francisco, the primary domestic market. As the figures prior to 1913, however, are not complete in the Mining and Scientific Press, they have been taken, for the years 1908–1912, inclusive, from the Engineering and Mining Journal. Obviously, the figures given in this table, being annual averages, may differ considerably from the price actually quoted or obtained on a particular date.

Average yearly prices of quicksilver in the United States and the United Kingdom from 1908 to 1919, inclusive.

[Per flask of 75 pounds.]

Year.	San Francisco [a] (domestic).	New York.[b]	London.[c]			Year.	San Francisco [a] (domestic).	New York.[b]	London.[c]		
			£	s.	d.				£	s.	d.
1908	$44.17	$44.84	8	4	8	1914	$49.05	$48.31	[d] 7	15	0
1909	45.45	46.30	8	12	0	1915	85.80	87.01	14	10	8
1910	46.51	47.06	8	16	0	1916	125.89	125.49	17	2	10
1911	46.01	46.54	8	4	11	1917	105.32	106.30	22	4	3
1912	42.05	42.46	8	2	10	1918	117.50	123.47	[e]		
1913	40.23	39.54	7	9	2	1919	90.29	92.15	20	9	5½

[a] Min. and Sci. Press, San Francisco.
[b] Eng. and Min. Jour., New York.
[c] Min. Jour. (London).
[d] Metal exchange closed about three months after outbreak of war. Average based on 37 weeks only.
[e] Quoted as "nominal" only.

Although San Francisco is commonly referred to as the "primary market" for quicksilver in the United States, from the fact that the greater part of this metal produced in the country comes from the Pacific coast and goes through the hands of San Francisco firms, yet it should be noted that that city is not a market in the same sense as New York. Most of the quicksilver that passes nominally through San Francisco is handled on commission and is sold in New York, which consequently is the great distributing point of quicksilver to the actual consumers.

Prices of domestic quicksilver at San Francisco, 1917–1919.

[Per flask of 75 pounds.]

Month.	1917	1918	1919	Month.	1917	1918	1919
January	$81.00	$128.06	$103.75	July	$102.00	$120.00	$100.00
February	126.25	118.00	90.00	August	115.00	120.00	103.00
March	113.75	112.00	72.80	September	112.00	120.00	102 60
April	114.50	115.00	73.12	October	102.00	120.00	86.00
May	104.00	110.00	84.80	November	102.50	120.00	78.00
June	85.50	112.00	94.40	December	117.42	115.00	95.00

IMPORTS AND EXPORTS.

The import duty on quicksilver from 1890 to 1895 was 10 cents a pound. From 1895 to 1913 it was 7 cents. The Underwood tariff bill enacted in 1913 and still in force made the duty 10 per cent ad valorem which, at the average price in London for 1919, at normal exchange, would be equivalent to an import tax of about 13.5 cents a pound.

In the following tables[4] are given imports of quicksilver for domestic consumption, total annual exports, and annual exports by countries. In 1919 the imports were greater by 293,706 pounds, or

[4] Compiled by J. A. Dorsey from the records of the Bureau of Foreign and Domestic Commerce, Department of Commerce.

about 3,916 flasks, than in 1918, and the increase in the total value of the imports was $257,604. The exports showed a still larger increase, amounting to 450,658 pounds, or about 6,009 flasks, more than in 1918, with an increase in value of $478,708. About 61 per cent of the quicksilver exported went to Japan, nearly 27 per cent to Hongkong, about 4 per cent to Sweden, and less than 3 per cent to Canada. This is in marked contrast with 1918, when Canada took 203,900 pounds, or about 87.7 per cent of the quicksilver exported from the United States.

Quicksilver imported and entered for consumption in the United States, 1910–1919.

Year.	Quantity.			Value.
	Pounds.	Metric tons.	Approximate equivalent in flasks of 75 pounds.	
1910	667	0.30	9	$381
1911	471,944	214.07	6,292	251,386
1912	82,706	37.52	1,103	39,920
1913	171,653	77.86	2,289	75,361
1914	614,869	278.90	8,198	271,984
1915	421,884	191.37	5,625	282,752
1916	424,396	192.50	5,659	515,919
1917	390,494	177.13	5,207	448,032
1918	503,907	228.57	6,719	533,622
1919	797,613	361.79	10,635	791,226

Quicksilver exported from the United States 1910–1919.

Year	Quantity.			Value.
	Pounds.	Metric tons.	Approximate equivalent in flasks of 75 pounds.	
1910	144,237	65.42	1,923	$91,077
1911	21,841	9.91	291	13,995
1912	23,283	10.56	310	13,360
1913	85,521	38.79	1,140	43,574
1914	108,426	49.18	1,446	70,753
1915	252,852	114.69	3,372	225,509
1916	666,027	302.11	8,880	670,475
1917	808,336	366.66	10,778	998,470
1918	232,346	105.39	3,098	338,620
1919	683,004	309.80	9,107	817,328

Domestic quicksilver exported from the United States, 1918–19, by countries.

Destination.	1918		1919	
	Quantity.	Value.	Quantity.	Value.
Europe:	*Pounds.*		*Pounds.*	
Denmark			11,200	$21,300
England	19,550	$32,500		
Greece			45	75
Iceland and Faroe Islands	13	32		
Norway			3,000	4,750
Sweden			20,750	43,571
North America:				
Canada	203,900	295,349	18,827	24,745
Mexico	28	46	991	1,185
Central America:				
British Honduras	3	7		
Guatemala	10	21	75	120
Honduras	24	30	225	260
Nicaragua	265	340	150	130
Salvador	12	25	375	668
West Indies:				
British:				
Barbados	2	4		
Trinidad and Tobago	213	212	10	20
Other	1	4	2	4
Cuba	463	782	1,084	1,705
Dominican Republic	10	18	25	53
Dutch	5	9		
Haiti	26	53	3	7
Virgin Islands of the United States	60	100		
South America:				
Argentina	22	34	306	348
Bolivia			14	13
Brazil	32	71	911	1,350
Chile			1,827	2,225
Colombia	96	170	2,568	3,510
Ecuador	10	19	10	22
Guiana:				
Dutch			75	75
French	150	250	1,105	1,424
Peru			2,200	2,359
Uruguay			75	175
Venezuela			275	456
Asia:				
China	20	50	1,129	1,193
Chosen (Korea)	450	720	404	525
Hongkong			181,700	212,240
India (British)	10	20	3,750	3,250
Japan			417,710	485,745
Siberia			75	100
Straits Settlements	1,068	1,500	12	12
East Indies, Dutch	86	146	1,961	2,324
Oceania:				
Australia	805	804		
French (New Caledonia)			1	2
New Zealand	75	125	150	170
Philippine Islands	637	953	531	629
Africa:				
British South Africa	4,300	4,206	450	588

USES OF QUICKSILVER.

The following are the principal uses of quicksilver under normal conditions, stated in general order of decreasing importance. Quicksilver enters largely into the manufacture of drugs and chemicals, including calomel and corrosive sublimate. Mercuric oxides and mercury salts are also used extensively in the manufacture of certain chemicals, such as glacial acetic acid, phthalic acid, and phthalic anhydride, into which mercury does not itself enter. Mercury fulminate, with the chemical formula $Hg(CNO)_2$, is used as a detonator

for high explosives,[5] and to a less extent than formerly in small-arms ammunition. It is made by treating mercury with strong nitric acid and alcohol.

The discovery of mercury fulminate in 1799 led to the invention of the percussion cap in place of the old flintlock, and fulminate still remains the best-known and most-used detonator for gunpowder and high explosives. It is often combined with other substances, particularly with an abrasive, such as powdered glass, to increase its sensitiveness, and with compounds or mixtures that themselves have the property of detonating, such as sulphide of antimony and chlorate of potassium. Recently a large part of the mercury fulminate in detonators for modern high explosives has been replaced by picric acid, trinitrotoluene, or tetranitromethylamine, whereby a much stronger initial effect is obtained and one part of mercury fulminate is made to detonate a charge that would have required six times as much fulminate used alone. Other substances have been found also which seem likely to replace mercury fulminate entirely for certain uses. One of these is lead azide, a salt of hydronitric acid. Large dry crystals of this salt are so sensitive as to explode when brushed with a feather, but smaller crystals are less sensitive. Other proposed substitutes are lead styphnate, $PbC_6(NO_2)_{12}O_2$; hexamethylamine triperoxidediamine, $N(CH_2O.OH_2C)_3N$, said to be four or five times as strong as mercury fulminate; nitrogen tetrasulphide, N_4S_4; diazobenzolnitrate, $C_6H_5N_2(NO_3)$; basic mercury nitromethane; and perchlorate of trimercuraldehyde.[6]

As mercuric sulphide, mercury forms the brilliant red pigment vermilion. The metal is employed extensively in electrical apparatus, including rectifiers for changing alternating into direct current, mercury-vapor lamps, and storage batteries. In the manufacture of felt hats from rabbit's fur, mercuric nitrate is used to roughen the hairs so that they will adhere together, a process technically known as "carroting." Metallic quicksilver is employed in the amalgamation of gold and silver ores, although of late years the wide application of the cyanide process has decreased this use. In the metallic state also the metal is utilized in the manufacture of instruments, thermostats, gas governors, and other appliances. Mercury enters into the composition of some antifouling marine paints for ship bottoms, a modern and at present a rapidly increasing use. The mercury for this purpose is generally employed as the red mercuric oxide, its efficacy depending upon the gradual conversion of the oxide to the poisonous bichloride by the sodium chloride of salt water. About 12 ounces of mercuric oxide or 11 ounces of metallic mercury is contained in each gallon of paint, which covers 243 square feet. Mercury is also used in certain compounds for preventing boiler scale, in cosmetics, and in dental amalgam. Mercury was formerly much used for silvering mirrors, but this method has been largely supplanted by the silver nitrate process. Mercury, however,

[5] Detailed specifications for mercury fulminate for military use have been prepared for the Ordnance Department, U. S. A., by H. C. Pritham, chief chemist, Frankford Arsenal; Dr. C. G. Storm, design section, Ordnance Department; and Capt. Paul McMichael, design section, Ordnance Department.

[6] Most of the statements in this paragraph are taken from a paper by Walter Arthur (Initiation of explosives: Jour. Ind. and Eng. Chemistry, vol. 9, pp. 392–395, 1917). Some of the chemical formulas are too complex to reproduce here.

is believed to give the more lustrous reflecting surface, and the art of mercurial silvering was temporarily revived about 17 years ago in making the mirrors of the St. Regis Hotel, New York City. It apparently has not been in use since. A small quantity of quicksilver, not more than 2 or 3 flasks annually, is used in floating certain types of revolving lights in lighthouses. The quicksilver so used, like that in some instruments and appliances, such as gas governors, is not consumed in the ordinary course of events, and additional quantities are required only when new installations are made. Quicksilver is also used as the cathode in certain electrolytic processes for manufacturing chlorine and caustic soda from common salt. The quicksilver combines with metallic sodium as sodium amalgam, which, in the presence of water, immediately reacts and forms metallic mercury and sodium hydrate. Mercuric oxide parts with oxygen readily and is a useful oxidizing agent in certain chemical processes. An important modern utilization of this property is in the manufacture of glacial acetic acid by the oxidation of acetylene.

Phthalic anhydride, an organic compound important in the dye and drug industries, has been extensively made, especially in Germany, by reactions involving the use of mercury as mercuric sulphate. About 40 pounds of mercury is required to make 1,000 pounds of phthalic anhydride, and from 10 to 20 per cent of this mercury is recoverable after each operation. For some years, however, at least one firm in the United States has manufactured phthalic anhydride without the use of mercury salts, and recently the Secretary of Agriculture has announced that the Bureau of Chemistry has devised a process whereby air, instead of a mercury salt, is used in the manufacture of the anhydride. The new process is said to be in successful operation, and in consequence phthalic anhydride has recently been sold in this country as low as 45 cents a pound, whereas during the war it brought as much as $7 a pound.[7]

As mentioned in the reports for 1917 and 1918, experiments have been carried out on a considerable scale to determine the possible advantage of using mercury vapor in tandem mercury and steam boilers with turbine power generators. These experiments are still in progress.

Mercurous nitrate and mercuric chloride, or corrosive sublimate, are used extensively in testing brass artillery cases and fuses. The articles to be tested are immersed for 15 minutes in the nitrate solution or for 4 hours in the chloride solution, and are then examined for such cracks as may have been made visible by the action of the solution.

According to a recent British patent (G. H. Worrall, No. 141122, Jan. 6, 1919) the hardness of certain lead alloys, particularly those containing alkali earths or alkali metals, is increased by the addition of small quantities of mercury. A recent German patent is reported to be in use in Germany for making stereo and type-metal alloys in which quicksilver is substituted for tin.[8]

[7] Chem. and Met. Eng., vol. 23, No. 14, p. 703, 1920.
[8] Mining Jour. (London), Feb. 28, 1920.

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From data collected chiefly by J. P. Dunlop, under the supervision of H. D. McCaskey, both of the Geological Survey, it was estimated that the principal purposes for which quicksilver was used in the United States in 1917 were as follows:

Quicksilver used for certain purposes in 1917.

	Flasks of 75 pounds.
Drugs and chemicals	8,500
Fulminate	4,850
Vermilion	3,130
Oxide (for antifouling marine paint)	3,000
Electrical apparatus (batteries, electrolyzers, rectifiers, lamps, etc.)	2,700
Felt manufacture (especially hats)	1,700
Gold and silver amalgamating mills	850
Instruments, thermostats, gas governors, automatic sprinklers, etc.)	630
Miscellaneous, including boiler compounds and cosmetics	1,000
	26,360

The Geological Survey is not attempting annual revision of these estimates but expects in the course of the next few years, when more nearly normal conditions have been reached, to make a new canvass of the consumers of quicksilver.

In the following table the sum of the domestic production and imports less the exports is shown as apparent consumption. The apparent consumption in 1919 fell short of the total of the foregoing estimate by 3,417 flasks. This is not at all surprising in view of the cessation of the demand for quicksilver for war purposes and the probable existence of large stocks on hand whose utilization would not appear in the figures given under "Apparent consumption."

Supplies of quicksilver in the United States, 1913–1919.

Year.	Production.		Imports.		Exports.		Apparent consumption.	
	Quantity (flasks).	Value.	Quantity (flasks).	Value.	Quantity (flasks).	Value.	Quantity (flasks).	Value.
1913	20,213	$813,171	2,289	$75,361	1,140	$43,574	21,362	$844,958
1914	16,548	811,680	8,198	271,984	1,446	70,753	23,300	1,012,911
1915	21,033	1,804,631	5,625	282,752	3,372	225,509	23,286	1,861,874
1916	29,932	3,768,139	5,659	515,919	8,880	670,475	26,711	3,613,583
1917	36,159	3,808,266	5,207	448,032	10,778	998,470	30,588	3,257,828
1918	32,883	3,863,752	6,719	533,622	3,098	338,620	36,504	4,058,754
1919	21,415	1,933,560	10,635	791,226	9,107	817,328	22,943	1,907,458

CONSUMPTION OF QUICKSILVER IN GOLD AND SILVER MINING.

Quicksilver is utilized to amalgamate with and retain native gold, both in quartz milling and in placer mining. Under ideal conditions the metal so employed would be recoverable and could be used over and over. In practice, however, there is some loss, which, according

to Sharwood,[9] who has given this subject careful study, usually ranges from 0.005 to 0.01 pound avoirdupois, or from 0.07 to 0.15 ounce troy, to each ton of low-grade ore treated in modern mills. The following table gives approximately this loss for each State, including probably some quicksilver purchased during the year for new or enlarged milling operations. The figures given for Alaska are the least reliable, as they are based for the most part on statements of the cost of the quicksilver consumed annually in the large mills on Douglas Island with small, arbitrarily assumed additions for the smaller mills in the Territory. In the summer of 1916 amalgamation on Douglas Island was replaced by the cyanide process.

Quicksilver consumed in gold-quartz milling in United States, 1913–1918, in pounds.

State.	1913	1914	1915	1916	1917	1918
Alaska	*a* 7,500	*a* 7,500	*a* 5,750	*a* 7,750	*a* 6,000	*a* 4,000
Arizona	*b* 1,500	*c* 1,802	*c* 547	*c* 645	*c* 205	*c* 17
California	*d* 17,000	*d* 17,500	*d* 19,600	*d* 19,300	*d* 18,400	*d* 15,000
Colorado	*e* 10,834	*e* 6,059	*e* 6,014	*e* 5,237	*e* 3,800	*e* 6,050
Idaho	*f* 254	*f* 598	*f* 1,040	*f* 1,183	*f* 1,035	*f* 953
Montana	*b* 200	*c* 408	*c* 371	*b* 206	*c* 167	*c* 99
Nevada	*b* 1,600	*b* 6,826	*c* 4,367	*c* 2,111	*c* 839	*c* 675
New Mexico	*e* 133	*e* 365	*e* 368	*e* 280	*e* 175	*e* 279
Oregon	*b* 350	*b* 400	*d* 1,690	*d* 3,700	*d* 2,687	*d* 2,200
South Dakota	*e* 12,160	*e* 13,500	*e* 13,900	*e* 12,516	*e* 13,199	*e* 12,252
Utah	*b* 30	*b* 20	*c* 30	*c* 15	*c* 5	*c* 2
Washington	*f* 130	*f* 43	*f* 28	*f* 317	*f* 185	*f* 20
	51,691	55,021	53,705	53,260	46,697	41,547

a Rough estimate based on cost of quicksilver consumed as given in annual reports of Alaska gold-mining companies (F. L. Ransome).
b Estimate based on bullion produced by amalgamation (H. D. McCaskey).
c Heikes, V. C., U. S. Geol. Survey Mineral Resources, 1913–1917.
d Estimate (F. L. Ransome).
e Henderson, C. W., U. S. Geol. Survey Mineral Resources, 1913–1917.
f Gerry, C. N., idem.

The quantity of quicksilver used in sluicing, hydraulic mining, and dredging, and the proportion of it lost, vary widely with the character of the gravel and the coarseness of the gold. In modern gold dredging the quantity lost annually by each dredge is very small, and according to William S. Noyes,[10] of the El Oro Dredging Co., averages, roughly, about a flask. An attempt was made to estimate the quantity lost annually in placer mining in each State and to prepare for this branch of the mining industry a table similar to that just given, but the data available proved insufficient for this purpose. Probably from 15,000 to 20,000 pounds, or from 200 to 265 flasks, is lost annually in California in placer mining, including dredging, and possibly twice as much in the country as a whole.

In the following table, compiled by V. C. Heikes, of the United States Geological Survey, some details are given for the consumption of quicksilver in the recovery of gold and silver in six Western States from 1911 to 1918, inclusive:

[9] Sharwood, W. J., Loss of quicksilver in gold mills: Min. and Sci. Press, Apr. 6, 1918, p. 483.
[10] Letter, Aug. 12, 1918.

Quicksilver consumed in certain Western States, 1911–1918.

State and year.	Number of mills using quicksilver.	Ore and tailings treated.	Total quicksilver.[a]	Quicksilver consumed (average per ounce of gold and silver bullion).
		Short tons.	*Pounds.*	*Pound.*
Arizona:				
1911	26	46,833	1,362.00	0.086
1912	40	28,028	1,414.30	.098
1913	18	36,337	2,912.68	.158
1914	22	44,808	1,802.00	.116
1915	32	34,360	547.00	.063
1916	13	17,568	645.00	.040
1917	9	21,100	205.00	.057
1918	7	1,389	17.00	.012
Idaho:				
1911	35	72,210	1,648.00	.057
1912	43	34,609	700.00	.020
1913	40	28,258	254.00	.019
1914	29	25,877	598.00	.042
1915	36	46,423	1,040.00	.027
1916	36	66,304	1,183.00	.039
1917	27	63,884	1,035.00	.032
1918	22	31,263	953.00	.057
Montana:				
1911	24	61,767	898.00	.031
1912	17	48,837	783.59	.047
1913	23	14,508	289.57	.077
1914	18	29,983	408.00	.074
1915	24	28,504	371.00	.051
1916	18	18,959	206.00	.026
1917	13	8,925	167.00	.040
1918	13	6,492	99.00	.053
Nevada:				
1911	56	781,463	4,753.00	.012
1912	49	388,714	6,636.73	.044
1913	39	360,579	5,054.73	.051
1914	42	250,408	6,826.00	.063
1915	47	211,729	4,367.00	.038
1916	36	131,891	2,111.00	.034
1917	32	67,359	839.00	.020
1918	34	54,048	675.00	.01
Utah:				
1911	6	5,020	105.00	.058
1912	4	588	27.70	.145
1913	3	1,157	71.81	.107
1914	2	533	20.00	.108
1915	3	1,399	30.00	.020
1916	4	703	15.00	.039
1917	2	190	5.00	.030
1918	2	112	2.00	.018
Washington:				
1911	5	11,846	526.00	.197
1912	9	4,609	121.00	.043
1913	9	768	43.82	.038
1914	5	2,146	43.00	.039
1915	3	1,286	28.00	.031
1916	5	11,495	317.00	.027
1917	4	10,976	185.00	.026
1918	1	960	20.00	.038

[a] Partly estimated.

GENERAL GEOGRAPHIC AND GEOLOGIC RELATIONS OF QUICKSILVER DEPOSITS.

The distribution and mode of occurrence of quicksilver deposits were treated rather fully in the report for 1917, and that information will not be repeated here. No new deposits of consequence were found in 1919.

Appended to the report for 1918 is a table in which are listed the quicksilver mines of the United States, with brief notes on the character and geologic relations of the ore bodies and data concerning development, equipment, and production.

From the data assembled in this chart the approximate proportions of the total output of quicksilver obtained in the United States from various rocks, or groups of rocks, is as follows:

	Per cent.
Serpentine, associated with the early Cretaceous or late Jurassic Franciscan group of the Pacific coast	64
Sandstones and shales of the Franciscan group and subordinately of the Cretaceous Knoxville shale, the ore generally close to serpentine	21
Radiolarian chert, of the Franciscan group	5
Tertiary and younger volcanic rocks, chiefly basalt and andesite in the Coast Ranges and rhyolite in Nevada	5
Limestones and calcareous shales, chiefly the Cretaceous of Texas, but subordinately early Mesozoic limestones in Nevada	3
Tertiary sandstone, pre-Cambrian schist	2
	100

It appears that about 90 per cent of all the quicksilver mined in the United States has come from the serpentine and the intimately associated sedimentary rocks of the Franciscan group, with which, in the present inquiry, is included some Knoxville shale.

MINERALOGY OF QUICKSILVER ORES.

GENERAL CHARACTER OF ORES.

Quicksilver ores as a rule are comparatively simple in mineralogical character. About 25 mercurial minerals are known, but most of them are rare, and to few quicksilver miners does "quicksilver ore" suggest anything but rock containing the brilliant red sulphide cinnabar, with perhaps some native mercury and possibly a little of the black or dark-gray sulphide metacinnabar. These minerals are commonly associated with more or less iron sulphide in the form of pyrite or marcasite. The mercury minerals and associated sulphides may be scattered in small specks through sandstone or other porous rock; they may occur as irregular streaks or bunches in altered rocks of various kinds; or, with calcite, barite, or quartz as gangue minerals, they may form definite veins, although these are rarely of regular form.

A large number of the deposits in California are in serpentine, and in these the cinnabar and accompanying sulphides occur in dark opal or in carbonates of calcium, magnesium, and iron, or in mixtures of opal and carbonates. In Nevada many of the deposits are in rhyolite, which in the vicinity of the cinnabar is generally much altered. In some localities the rhyolite has been changed to a very hard granular rock resembling quartzite, in others it has been converted to white opal, and in others to soft masses of sericite or kaolinite. Various mixtures of these minerals are also common.

In certain localities the sulphide of antimony, stibnite, is fairly abundant with the cinnabar, and most quicksilver deposits, especially in California, contain small quantities of an oily or asphaltic hydrocarbon.

MINERALS CONTAINING MERCURY.

The mineralogy of quicksilver deposits was fully described in the report for 1917, copies of which are still available for distribution.

TENOR OF ORES.

The richest quicksilver ores worked on a large scale are those of Almaden, Spain, where the average metal content won from the ore in 1918 was about 6.5 per cent. Probably the lowest tenor in ores that are successfully worked is found on the Pacific coast of the United States. The average metal content won from the California ores in 1916 and 1917 was 0.38 per cent; in 1918, when very low-grade material at Sulphur Bank was being handled with a steam shovel and was concentrated before being retorted it was only 0.24 per cent, and the average in furnace operations was 0.30 per cent; and in 1919 the general average for California ores was 0.41 per cent and the average for furnace ore 0.42 per cent. In Texas, in 1918, the average for furnace ore was 0.87 per cent and for ore treated in retorts 0.88 per cent; in 1919 the figures were respectively 0.49 and 0.35 per cent. The average for all ore treated in furnaces in the United States in 1919 was 0.43 per cent. The ore at Idria, Austria, according to the latest information available, averages about 0.65 per cent. In the Monte Amiata district, Italy, the ores are reported to range in tenor from 0.25 to 30 per cent, the average for the district in 1913 being 0.89 per cent.

QUICKSILVER-MINING INDUSTRY, BY STATES.

ALASKA.

No production was recorded in 1919 from Alaska, but Brooks and Martin[11] report that work was in progress at the Parks quicksilver mine (see report on quicksilver in Mineral Resources, 1917, Part I, p. 399) on the lower Kuskokwim and that retorts were set up near the end of the year. About 30 men are said to have been employed at the mine.

The occurrence of cinnabar in many of the gold placer deposits in Alaska has long been known. George C. Martin reports[12] that a dredge operating on Candle Creek, in the Kuskokwim region, obtains annually in its sluice boxes several hundred pounds of cinnabar, which, however, is not utilized. The cinnabar is associated with quartz and is found in masses as large as a man's fist.

ARIZONA.

Arizona produced no quicksilver, so far as known, in 1919. Prospecting and development were continued, however, on the Hughes and Porterie groups of claims in the Phoenix Mountains, Maricopa County, on deposits described by Schrader.[13] On the Hughes group

[11] Brooks, A. H., and Martin, G. C., Alaska mining industry in 1919: U. S. Geol. Survey Bull. 714, pp. 93–94, 1921.
[12] Oral statement to writer.
[13] Schrader, F. C., Quicksilver deposits of the Phoenix Mountains, Ariz.: U. S. Geol. Survey Bull. 690, pp. 95–110, 1918.

an inclined shaft, 100 feet deep, has been sunk and a crosscut run about 30 feet to the east. The Mercury shaft, on the Porterie group, is reported to be 110 feet deep. The principal lodes, three in number, strike northeast to north-northeast and are shear zones in schist, carrying cinnabar, metacinnabar, and a little native quicksilver, with quartz, calcite, and iron oxide, the last presumably from pyrite or marcasite. In the Mazatzal Range, where similar deposits have been described by Ransome,[14] prospecting has continued and some additional occurences of ore have been discovered. The retorts of the Sunflower Cinnabar Mining Co. were not in operation in 1919.

CALIFORNIA.

PRODUCTION.

There was less activity in quicksilver mining in California in 1919 than in 1918. Among the mines that were productive in 1918 but were idle throughout 1919 or were closed in that year are the Sulphur Bank, Patriquin (Cholame), Aetna, La Joya, Rutherford (Bella Union), St. Johns, Culver-Baer, Great Eastern, and Socrates. The New Guadalupe and New Idria mines also produced much less than in 1918. On the other hand, the Dawson mine, in Kings County, increased its output, and a beginning was made in reopening the Klau mine. The production of the State was 15,205 flasks in 1919, valued at $1,372,859. Ot this total 14,335 flasks was obtained by furnace reduction, 183 flasks by retorting, and 687 flasks by washing out metallic quicksilver, mostly that which had escaped by leakage from old reduction works at New Almaden. The output in 1918 was 22,664 flasks, valued at $2,663,020. There was, therefore, in 1919 a decrease of 7,459 flasks, or 32.9 per cent, as compared with 1918, and a decrease in the total value of $1,290,161, or 48.4 per cent. California produced 71 per cent of the total quicksilver output of the country in 1919, as compared with 68.9 per cent in 1918.

In the following table, which gives the annual yield of quicksilver in California from 1910 to date, the quantities are recorded in the present standard for domestic flasks of 75 pounds:

Quicksilver produced in California, 1850–1919.

Year.	Flasks.	Value per flask.	Value.	Year.	Flasks.	Value per flask.	Value.
1850–1909	2,068,097	.....	$92,743,017	1916	21,045	$125.89	$2,649,355
1910	17,211	$46.51	800,484	1917	23,938	105.32	2,521,151
1911	18,860	46.01	867,749	1918	22,664	117.50	2,663,020
1912	20,524	42.05	863,034	1919	15,205	90.29	1,372,859
1913	15,591	40.23	627,228				
1914	11,303	49.05	554,414		2,248,721	.....	106,887,792
1915	14,283	85.80	1,225,481				

As usual, San Benito County, in which are situated the New Idria workings, at present the most productive quicksilver mine in the Western Hemisphere, leads, producing nearly half of the total output of the State. It is followed by Santa Clara County, which con-

[14] Ransome, F. L., Quicksilver deposits of the Mazatzal Range, Ariz.: U. S. Geol. Survey Bull. 620, pp. 111–128, 1915.

tains the New Almaden, the largest, the deepest, and in total output the most productive quicksilver mine in the United States, and the New Guadalupe mine. Sonoma County is still third in rank, all but a very small part of the output coming from the Cloverdale mine. In San Luis Obispo County, fourth in productivity, the Oceanic is even more conspicuously the leading mine, although its yield was less than in 1918. Napa County produced more than Lake County in 1919, but both fell far below their record for 1918.

Twenty operators reported production in California in 1919, as against 33 in 1918. Of these, two, the New Almaden Co. (Inc.) and the New Idria Quicksilver Mining Co., were each conducting productive operations at two distinct mines at adjacent localities under one management. At 13 localities the metal was obtained by furnace reduction from mines having as a rule considerable development, although at only four of them was the ore hoisted by machinery. At two mines some ore was retorted in addition to that treated in furnaces. At six localities quicksilver was won by retorts from mines generally but not invariably less developed than those equipped with furnaces. Altogether about 137,370 tons of ore was mined, and about 138,019 tons was treated. Of the ore treated, 126,498 tons was sent through furnaces and about 1,150 tons was retorted. At New Almaden 685 flasks of quicksilver was recovered by passing through a washer 10,351 tons of material excavated from the site of abandoned reduction works.

Quicksilver produced in California, 1919, by counties.

County.	Quantity (flasks of 75 pounds).	Value.
Lake	217	$19,592
Napa	868	78,372
San Benito	7,400	668,146
San Luis Obispo	1,291	116,564
Santa Clara	3,012	271,954
Sonoma	1,375	124,149
Others[a]	1,042	94,082
	15,205	1,372,859

[a] Includes Kern, Kings, Santa Barbara, Solano, and Trinity counties, in each of which there was only a single productive mine. More than half of the output here combined was from Kings County. There was only one producer in San Benito County, but as that company publishes its output in its annual report, abstracts of which have appeared in the mining press, there can be no objection to stating here the output of the county separately.

COLUSA COUNTY.

The mines of the Sulphur Creek district, near Wilbur Springs, were idle throughout the year.

FRESNO COUNTY.

There is no record of any production in Fresno County in 1919. The leading mine, the Mercy, equipped with a 20-ton Scott furnace, was idle.

KERN COUNTY.

The Cuddeback mine, 2 miles from Woodford, produced a small quantity of quicksilver during the first half of 1919, but was not operated during the latter part of the year.

KINGS COUNTY.

The Dawson mine, operated by the Patriquin Mining Co., was productive up to December 12, when the furnace was cooled for repairs. The ore from this mine is hauled 2 miles uphill and over a poor road to the 10-ton Scott furnace of the now idle Kings mine. At the end of the year horses were replaced by a tractor. Development during the year is reported to have increased the known supply of available ore.

LAKE COUNTY.

The Helen mine was worked throughout the year with a small force. The furnace was started about June 1 on ore mined earlier in the year and was operated until the end of October. It was then allowed to cool, and the accumulated soot in the condensers was retorted during November and December. This has lately been the practice at this mine, the furnace product being entirely soot, which is retorted during the winter. Consequently the mine yields no metallic quicksilver during the summer. The output from the other mines in Lake County was extremely small. The Sulphur Bank mine was idle, only a few flasks being produced early in the year from cleaning-up operations. The Big Chief, which in 1917 gave promise of considerable production, yielded no quicksilver during the later part of 1919. Development, however, is in progress.

MONTEREY COUNTY.

No production was reported from Monterey County, and the Patriquin mine, near Parkfield, was idle, the Patriquin Mining Co. having transferred its activities to the Dawson mine in Kings County.

NAPA COUNTY.

The old Oat Hill mine, the reopening of which was described in the report for 1917, was the only considerable producer in Napa County in 1919. The ore, generally of low grade, was treated in a new 35-ton Scott furnace. The Aetna mine, the leading producer in Napa County in 1918, was idle during 1919, it being found impossible under the prevailing high cost of labor and supplies to work profitably ore of the grade obtainable.

At the Rutherford (Bella Union) mine a rotary furnace was operated from January 1 to the end of February. The mine was idle from March 1 to November 30, but made a very small production from retorts in December. The La Joya mine was not operated in 1919.

SAN BENITO COUNTY.

The only producer of quicksilver in San Benito County in 1919 was the New Idria Quicksilver Mining Co., which operates the New Idria and San Carlos mines. These mines were worked continuously from the beginning of the year to April 10. They were then closed to wait more favorable conditions for obtaining labor and supplies and a better market for quicksilver. After about two months' idleness, work was resumed.

The company's published annual report states that

The total production of quicksilver for the year was 7,400 flasks, as compared with 10,700 for the previous year. This smaller production was due to unsettled market conditions in the early part of the year, resulting from the reconstruction period, which necessitated our curtailing operations at the mine. This resulted in a loss of production of approximately three months, or 2,500 flasks.

Our new reduction plant, consisting of five rotary kilns and condensing system, was completed during the year, including the installation of conveyor belts, crushers, etc., also an aerial tramway to carry away the burned ore from the furnaces. This new plant has a roasting capacity of from 400 to 500 tons of ore per day, and with the mill unit which can be operated when required gives us the largest quicksilver reduction plant in America, if not in the world. This plant is flexible in capacity, any unit can be shut down and started within two hours, and requires about one-third the labor formerly necessary to operate with the old furnaces. All ore is automatically handled from the point of sorting at the mines. Losses are reduced to a minimum, 95 per cent being recovered directly in the furnaces, and practically all of the remaining 5 per cent is saved by other processes. One of its greatest features is the elimination among employees of salivation by mercurial poisoning.

The old furnaces have been dismantled and we are still treating the ground underneath, in some places as deep as 60 feet, the free silver from the furnaces having penetrated to and beyond this depth. This leakage is entirely eliminated in our new reduction plant.

The electric power line was completed in April and the entire plant is operated with electric motors. This, together with our new plant, gives us a very economical and efficient operating equipment.

The labor situation is a serious one with us, but is no more so than with many other industries. If a better class of miners can be obtained, our production can be increased accordingly.

Costs of labor and supplies are continually advancing, but every effort is being made to counteract this by the strictest economy in management and utmost efficiency in operation.

The grade of ore continued very satisfactory during the year, and at the present time is of better grade and appearance than for several years past. We have developed many working faces, which can be worked provided the labor situation improves and additional miners can be secured.

Even under the partly adverse conditions mentioned in the company's report, the New Idria and San Carlos mines, generally referred to collectively as the New Idria mine, produced nearly half of the total output of quicksilver in California and more than twice as much as any other mine in the United States.

Some development work was reported from the French mine in the Stayton district.

SAN LUIS OBISPO COUNTY.

At the Oceanic mine only one of the two 50-ton Scott furnaces was in operation in 1919 after January 14. The discovery was reported of an ore body to the east of all previous workings. This ore was found on the 200 level (550 feet below the surface) and is said to average about 6 pounds of quicksilver to the ton, or 0.3 per cent.

An event of unusual interest was the reopening by the Carson Quicksilver Mining Co. of the Klau mine, which had been idle for several years. On December 11, 1919, Mr. E. W. Carson reported that he had 14 men at work. He states in a letter of that date:

A new tunnel located some 300 feet east of the old No. 1 or main tunnel has been driven 175 feet. Twenty-seven feet of ore was passed through of a value of 12 pounds of quicksilver to the ton. Drifts are now being run east and west

on this new ore body. Two other tunnels have been started to explore the ground still farther to the southeast. Later on a shaft will be sunk to a point at least 100 feet below all previous workings. It is quite possible that by next spring a sufficient tonnage of ore will be developed to warrant repairing the 50-ton Scott furnace and placing it in operation.

The furnace has since been started, and the mine will probably again become productive.

The Little Bonanza mine was worked in the latter part of 1919 by lessees and a few flasks of quicksilver was retorted from ore taken out in prospecting.

SANTA BARBARA COUNTY.

A small production was made in Santa Barbara County from retorted ore at the Red Rock (Acachuma) mine, and a little development work was done by the Los Prietos Quicksilver Mines Co. on the Los Prietos ground.

SANTA CLARA COUNTY.

At New Almaden the principal output, as in recent years, continued to come from the El Senador mine, about 4 miles northwest of the famous old workings in Mine Hill. On May 31 the buildings at the El Senador in which were housed a 40-ton Herreshoff furnace and a new 90-ton Scott furnace were destroyed by fire, but reconstruction was reported as nearly completed at the end of the year. The log washer at the hacienda at New Almaden continued in operation on material excavated from the site of dismantled furnaces and condensers.

The Guadalupe, operated by the New Guadalupe Mining Co., was less actively worked than in 1918 and during the later part of the year attention was directed chiefly to development and repairs.

SISKIYOU COUNTY.

No new information has been received concerning the deposits on Empire Creek, north of Gottville, where two retorts were set up in 1918.

SOLANO COUNTY.

The St. Johns was the only mine active in Solano County in 1919, and its output was less than in 1918.

SONOMA COUNTY.

The only mine continuously active in Sonoma County was the Cloverdale, operated by the Western Mercury Co. (Inc.). A new 80-ton Gould rotary furnace was completed in February and has proved successful. The Culver-Baer and Socrates mines were idle throughout the year, and the Great Eastern, after a small production, was shut down on March 1.

TRINITY COUNTY.

A little quicksilver was produced by lessees from the old dumps of the Altoona mine, near Castella.

YOLO COUNTY.

No report has been received of any activity in quicksilver mining in Yolo County.

IDAHO.

No production was reported from Idaho, although there was some development in the Yellow Pine district in Valley County. The Fern Quicksilver Mining Co. reports that preparations are being made for building a 50-ton Scott furnace in 1920. The geology of the district has recently been described by Larsen and Livingstone.[15]

NEVADA.

PRODUCTION.

The production of quicksilver in Nevada in 1919 was 756 flasks, valued at $68,259, against 1,044 flasks, valued at $122,670, in 1918. The number of operators reporting production at different mines was 6, as compared with 4 in 1918. The ore treated is estimated at 6,630 tons, which would give a yield of 8.6 pounds to the ton, or 0.43 per cent. The principal sources of quicksilver in Nevada in 1919 were the Mercury mine, near Ione, in Nye County, and ground leased from the Mina Mercury Co. in the Pilot Mountains, in Mineral County, east of Mina. The returns from both of these localities were incomplete or confusing, and it is not clear how much of the quicksilver obtained in the Pilot Mountains came from the Bugg & Drew (Red Devils) mine and how much from the Wardell & Booth mine.

Quicksilver produced in Nevada, 1910–1919.

Year.	Quantity (flasks).	Value per flask.	Value.	Year.	Quantity (flasks).	Value per flask.	Value.
1910	70	$46.51	$3,256	1915	2,327	$85.80	$199,65
1911	70	46.01	3,221	1916	2,198	125.89	276,70
1912	2,550	42.05	107,228	1917	997	105.32	105,00
1913	1,645	40.23	66,178	1918	1,044	117.50	122,67
1914	2,089	49.05	102,465	1919	756	.....	68,25

ELKO COUNTY.

No quicksilver was produced in the Ivanhoe Springs district, in Elko County.

HUMBOLDT COUNTY.

The Goldbanks mine, at one time the leading producer in Humboldt County, was nonproductive in 1919, and no activity was reported from any other locality in the county.

LANDER COUNTY.

A small output was made by the Quicksilver Mines Co., operating the Ruby group, about 75 miles south-southwest of Battle Mountain and 32 miles from Watts Station on the Nevada Central Railroad.

[15] Geology of the Yellow Pine cinnabar-mining district, Idaho: U. S. Geol. Survey Bull. 715–E, 1920.

MINERAL COUNTY.

The Red Rose mine, on Mount Montgomery, was operated by lessees for a few months during the summer and autumn, but the yield was very small. Reports of the activity in the Pilot Mountains, 14 miles east of Mina, are rather confusing. In 1918 the Bugg & Drew mine (formerly known as the Farnham & Drew or Red Devils mine) was recorded as under lease to the Mina Quicksilver Co., of Reno. On December 1 of that year, however, this mine, and another known as the Wardell & Booth, are reported to have been leased by the Mina Mercury Co., apparently a new organization, to Summerfield & Elges, of Mina. These lessees appear to have worked the Wardell & Booth up to the end of November, 1919, and produced considerable quicksilver. The workings are described as a 20° incline of 125 feet, with no levels. The exact location of this mine has not been ascertained. The ore was treated in two 1-ton D retorts. The same operators also worked the Bugg & Drew mine for the first quarter of the year, but produced very little quicksilver therefrom.

NYE COUNTY.

At the Mercury mine, near Ione, the 25-ton Scott furnace was operated for only a part of the year and less than half as much quicksilver was produced as in 1918. The adjacent Nevada Cinnabar mine was not operated in 1919

OREGON.

PRODUCTION.

The production of quicksilver in Oregon in 1919 amounted to 435 flasks, valued at $39,276, as against 702 flasks, valued at $82,485, in 1918. The Black Butte mine was still the leading producer, but was closed before the end of the year, and its place will probably be taken in 1920 by the War Eagle (Rainier) mine.

JACKSON COUNTY.

The War Eagle mine (formerly the Rainier) changed hands during the year and is now owned by the War Eagle Mining Co. The production for 1919 was made by means of a bank of Johnson-McKay retorts rated at 3 tons. The company reported that at the close of the year it was installing 6-ton retorts and expected to build a furnace in the spring of 1920. A very small output was made from the Little Jean mine, near Gold Hill.

LANE COUNTY.

The Black Butte, which up to the present time has been the most productive quicksilver mine in Oregon, was operated only during January and February, although some quicksilver was obtained later by retorting soot from the condensers.

TEXAS.

PRODUCTION.

There were five producing mines in Texas in 1919, all in Brewster County. The ore treated amounted to 38,864 tons and yielded 5,019 flasks, valued at $453,166, as against 8,451 flasks, valued at $992,992, in 1918. The production of Texas from 1910 to date is given in the following table:

Quicksilver produced in Texas, 1910–1919.

Year.	Quantity (flasks).	Value per flask.	Value.	Year.	Quantity (flasks.)	Value per flask.	Value.
1910	3,320	$46.51	$154,413	1915	4,417	$85.80	$378,979
1911	2,326	46.01	107,019	1916	6,306	125.89	793,862
1912	1,990	42.05	83,680	1917	10,791	105.32	1,136,508
1913	2,750	40.23	110,633	1918	8,451	117.50	992,992
1914	3,144	49.05	154,213	1919	5,019	.....	453,166

BREWSTER COUNTY.

The Chisos, the leading quicksilver mine in Brewster County, and second only to New Idria in its recent annual production, was active throughout the year, but owing to the lower grade of the ore mined and the difficulty in obtaining efficient labor the output was considerably less than in 1918.

The Mariposa mine produced some quicksilver from superficial workings early in the year, but from March on attention was turned especially to prospecting and development on the lower levels.

At Study Butte the Big Bend mine was productive throughout 1919. During the first half of the year most of the ore came from open cuts and shallow workings, but from July on the output was obtained mainly from ore mined near water level. Preparations were made to sink and explore the ground below water level. The 50-ton Scott furnace at the Big Bend was shut down for repairs during a part of July and the original large fire box was divided into two in order to obtain more uniform heating from the wood fuel fed by unskilled Mexican firemen.

During the year the lessees of the Texas-Almaden or Dallas mine lowered the water from the 50-foot to the 150-foot level and produced some quicksilver. The attempt to reopen the mine, however, was finally abandoned as not likely to be profitable, and the lease was terminated.

The Ellis mine, 6 miles from McKinney Springs, produced some quicksilver early in the year. It was then purchased by the Mariscal Mining Co. and renamed the Mariscal mine. The new company has as yet produced no quicksilver, but has been prospecting and developing with a view to building a 50-ton furnace if sufficient ore can be found to warrant operation on a large scale.

NOTES ON FOREIGN QUICKSILVER DEPOSITS.

SPAIN.

The outstanding feature of the quicksilver production of Spain in 1918, the latest year for which official statistics are available in the United States, was the marked falling off in the output of the Almaden mine, which normally yields over 98 per cent of the Spanish quicksilver. The production of this mine in comparatively recent years of its long history is given in the following table, compiled from the Estadística minera de España. The figures of this table may be compared with those given for Spain as a whole on page 150.

Quicksilver produced at the Almaden mine, Spain, 1900–1918.

Year.	Metric tons.	Flasks of 75 pounds.	Year.	Metric tons.	Flasks of 75 pounds.
1900	1,022.84	30,066	1910	1,102.82	32,417
1901	687.76	20,217	1911	1,478.82	43,470
1902	1,375.24	40,425	1912	1,223.75	35,972
1903	910.77	26,772	1913	1,223.30	35,959
1904	1,070.05	31,454	1914	935.22	27,491
1905	791.56	23,268	1915	1,200.10	35,277
1906	1,500.84	44,117	1916	771.18	22,669
1907	1,160.88	34,124	1917	827.11	24,313
1908	1,017.00	29,895	1918	544.65	16,010
1909	1,344.01	39,507			

It will be seen that in 1918 Almaden made the smallest production in its record for the twentieth century. Various reasons for this decrease are given in the official report. In accordance with a law passed on December 23, 1916, the management of the mine was placed in the hands of a council of seven, which, however, did not take control until the beginning of November, 1918. The mine at that time was in a bad condition. It was heavily in debt, development had been neglected, stopes had gone unfilled, supplies had not been replenished, and the equipment generally was old and out of repair. Operating expenses had increased greatly, and as the mine is run on a credit, granted at the beginning of each year by the official approval of a budget, the rapid increase in the cost of labor and materials was an additional factor making for disorganization. Production in 1918 was practically confined to the first 10 months. November and December were occupied in unwatering the twelfth level, repairing equipment, and in general preparation for work in 1919.

Mr. Courtney DeKalb, who, as United States trade commissioner visited the mine in July, 1919, has stated[16] that the ore bodies appeared to be less regular on the twelfth level than on the levels above, and he received the impression that decrease in production was due to a probably temporary lack of available ore. Sections of the workings, however, which he was kind enough to exhibit, did not indicate, in the opinion of the writer, that there is any lack of ore or that exhaustion of this famous old mine is anywhere in sight.

[16] Oral communication to F. L. Ransome.

ITALY.

Although in the Monte Amiata region wages, which before the war averaged about 3.50 lire a day (about $0.68 at normal exchange), rose to about 10 lire (nearly $2), the men struck for higher pay and the mines are reported to have been idle in July, August, and September.[17]

Italy apparently still controls the Idria mine, and information concerning the ultimate disposition of this productive deposit is conflicting. It is commonly reported that the mine will remain in Italian possession, but others having some knowledge of Italian affairs believe that it will go back to Austria.

Active prospecting for quicksilver ore by Italians in Dalmatia and the Trentino is reported by Mr. Dennis.

PERU.

In the report for 1917 it was mentioned that E. E. Fernandini, of Lima, was reopening the old Santa Barbara mine, at Huancavelica, Peru. Operations have continued and recently some additional details have been given by Singewald,[18] according to whom,

> The prevailing rock of the district is Cretaceous limestone, in which are intercalated zones of sandstone and shale. Outcropping over considerable areas are limestone conglomerates. The sediments are intruded by large masses of basalt and porphyrite, and along the mineralized zone are small andesite intrusions. A mineralized belt extends discontinuously from Chunamachay in a southeasterly direction through Huancavelica to beyond San Antonio, a distance of about 60 kilometers, and has a width of one to three kilometers. It follows a belt of sandstones in the limestone, and the ore usually impregnates the sandstones. Where they are compact and their texture is unfavorable and when the limestone has been shattered, the ore enters the latter rock. Some mineralization of the igneous rock has also occurred.

Maximum deposition of quicksilver ore, according to Singewald, took place in a particular layer of sandstone which strikes about north-northwest and dips steeply to the west-southwest. The rugged outcrops of this sandstone south of Huancavelica is known locally as the Grand Farallon, farallón being the Spanish term for a pointed rocky island. The cinnabar and associated sulphides occur chiefly as a filling of the interstices between the sand grains. In places cinnabar occurs alone, but generally it is associated with a dark hydrocarbon, pyrite or marcasite, and some galena. Rarely some realgar is present.

The new tunnel being driven by Fernandini to get under the old Santa Barbara workings will be at least 4,000 feet in length and is reported to be making satisfactory progress. Two small experimental furnaces have been built and are running on ore from the old workings, stated by Singewald to contain 0.2 per cent of quicksilver, whereas it is estimated that 0.5 per cent ore will be necessary in order to meet the expenses of operation.

Huancavelica is at present somewhat inaccessible. The nearest railway point is Huancayo, the terminus of one branch of the railroad that runs from Callao by way of Lima and Oroya to Cerro d

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[17] Dennis, A. P., commercial attaché, Rome, Italy, Commerce Repts., No. 43, pp. 1038–1041, 1920.

[18] Singewald, J. T., The Huancavelica mercury deposits, Peru: Eng. and Min. Journ. vol. 110, pp. 518–522, 1920.

Pasco. From Huancayo the distance by mule trail is 120 kilometers, or a two days' journey.

AUSTRALIA.

The following is quoted from the Official Year Book of the Commonwealth of Australia:[19]

In New South Wales mercury was first recorded by the Rev. W. B. Clarke in 1841. Cinnabar has been found in lodes and impregnations at various places, such as Bingara, Clarence River, etc. Up to the present the production of quicksilver has been small, the total being only about 3,000 pounds. During 1916 the Pulganbar Co. raised 200 tons of ore from their mine at Ewengar in the Drake division. The mercury produced was valued at £180. There was no production recorded in 1917. In Victoria native mercury and cinnabar have been found at Silver Creek, a tributary of the Jamieson River. Lodes of cinnabar have been found in Queensland at Kilkivan, and at Black Snake, in the Wide Bar district; about 4 tons were produced between 1874 and 1891. Between O. K. and Mungana several shows have been prospected with encouraging results. Small quantities have been found disseminated over a large area near Willunga in South Australia, and it is also found in New Guinea.

NEW ZEALAND.

A letter from the New Zealand Quicksilver Mines (Ltd.), 17 Swanson Street, Auckland, New Zealand, dated June 21, 1920, states:

The New Zealand Quicksilver Mines (Ltd.), after several years of fluctuating fortune, is now on the road to being a steady producer, and the directors are in hopes of being able ere long to install thoroughly up-to-date machinery, when the ore can be economically treated in large quantities. Small parcels have been sent from here to your country recently.

The location of the mines is not given. The only locality in New Zealand where prospecting is known to have been in progress is Puhi Puhi, on North Island.

DUTCH GUIANA.

According to United States consular reports float of quicksilver ore has been found at a number of places near Marowyne River, and cinnabar is said to have been discovered in place at one locality.

RECENT PUBLICATIONS ON QUICKSILVER IN NORTH AMERICA.

Compiled by Isabel P. Evans.

Bastin, E. S., Minor metals [mercury]: Strategy of minerals, edited by George Otis Smith, pp. 208–211, New York and London, 1919.

A brief sketch of the uses of quicksilver and its distribution. The process of separating the metal from the ore is so simple that every quicksilver miner may operate his own smelter.

Bell, R. N., Twentieth annual report of the mining industry of Idaho for the year 1918; War metals [quicksilver], pp. 89–100, 2 figs., 1919.

Gives a brief history of the quicksilver industry in the Yellow Pine district, now in Valley County, Idaho; the method of exploitation; and describes the occurrence of quicksilver in several localities.

Bradley, W. W., California mineral production for 1918, with county maps [quicksilver]: California State Min. Bur. Bull. 86, pp. 38, 60–70, July, 1919.

Reviews prices in 1918, the present economic situation, the concentration of quicksilver ores, the new equipment at the New Idria and other mines, the production by counties in 1918, and the total quicksilver production of California from 1850 to 1918.

[19] No. 12, p. 451, 1901–1918.

British Columbia Bureau of Mines. Annual report of the minister of mines for the year ending 31st December, 1918, being an account of mining operations for gold, coal, etc., in the Province of British Columbia [cinnabar, mercury], p. K 237, Victoria, B. C., 1919.

An examination of the deposits of cinnabar in the vicinity of Copper Creek, Kamloops Lake, which have not been worked since 1897, was made by Charles Camsell during the summer of 1918. His report will appear later.

Burcham, W. D., Quicksilver in Texas in 1918: Eng. and Min. Jour., vol. 107, No. 3, pp. 145–146, Jan. 18, 1919.

The Chisos, Mariposa, and Big Bend mines, in the Terlingua district, and the Ellis mine, about 40 miles farther east, were the producing properties in 1918.

Camsell, Charles, Mercury deposits of Kamloops Lake [British Columbia]: Canada Geol. Survey Summary Rept., 1918, pt. B, pp. 17 B–22 B, 1919.

The author states that it would have been necessary to clean out the old workings and sample the veins to arrive at an accurate estimate of the value of the deposit. The failure of this enterprise is attributed to inefficient metallurgic treatment.

Duschak, L. H., and Schuette, C. N., Fume and other losses in condensing quicksilver from furnace gases: U. S. Bur. Mines Tech. Paper 96, 29 pp., 5 tables, 4 figs., 1919.

Metallurgic experiments conducted by the Bureau of Mines at its experiment station at Berkeley, Calif.

Emmons, W. H., The anticlinal theory and some quicksilver deposits; Eng. and Min. Jour., vol. 107, No. 21, pp. 916–917, 1 fig., May 24, 1919.

A review of J. A. Udden's "The anticlinal theory as applied to some quicksilver deposits."

Engineering and Mining Journal, Average prices of principal metals for 24 years [quicksilver]: Vol. 107, No. 8, p. 352, Feb. 22, 1919.

The table of average prices is from 1895 to 1918.

Engineering and Mining Journal, The American quicksilver industry: Vol. 107, No. 20, pp. 878–879, May 17, 1919.

States there is need for prompt action if the American quicksilver industry is to be saved from collapse.

Fischer, A. H., A summary of mining in the State of Washington [quicksilver]: Washington Univ. Eng. Exper. Sta. Bull. 4, pp. 25, 34, 59, 61, 71, 73, 84, November, 1918.

The best known quicksilver deposits in the State of Washington are at Morton in northern Lewis County.

Foote, A. B., Tariff protection for metals: Min. and Sci. Press, vol. 119, p. 555, October 18, 1919.

The author is opposed to placing a protective tariff on such things as quicksilver, chromite, and potash. Says "the effect of artificially increasing the value of the ore in one mine will result in decreasing the value of the ore in another and can not result otherwise."

Forstner, William, Protecting the quicksilver industry: Min. and Sci. Press, vol. 118, No. 25, pp. 839–840, June 21, 1919.

A plea for organization to obtain a duty on imported quicksilver.

Forstner, William, Protection to the quicksilver industry: Min. and Sci. Press, vol. 119, No. 5, pp. 146–147, Aug. 2, 1919.

A brief reply to the articles by W. R. Ingalls and F. F. Sharpless, who oppose a high protective tariff for quicksilver.

Forstner, William, The American quicksilver industry: Eng. and Min. Jour., vol. 108, No. 8, pp. 321–322, Aug. 23, 1919.

Argument for a protective duty.

Gleim, E. M., The quicksilver industry: Min. and Sci. Press, vol. 119, No. 13, p. 434, Sept. 27, 1919.

A denial of the statement that the cinnabar deposits in Texas and Mexico are becoming lower in grade.

Gleim, E. M., A tariff on quicksilver: Min. and Sci. Press, vol. 119, No. 21, p. 739, Nov. 22, 1919.

Urges a protective duty that will make the industry stable.

Hamilton, Fletcher, The American quicksilver industry [letter to Hon. Franklin K. Lane, Secretary of the Interior]: Eng. and Min. Jour., vol. 107, No. 20, p. 879, May 17, 1919.

Suggests the licensing of imports to give the American producers the first call in supplying the small market that now exists for their product.

HARRINGTON, G. L., The gold and platinum placers of the Tolstoi district [Alaska; occurrence of cinnabar]: U. S. Geol. Survey Bull. 692, p. 350, 1919.

Cinnabar is found in small quantity in the Tolstoi district. It occurs as small pebbles, some measuring half an inch in diameter.

HUNLEY, J. B., [Quicksilver, one of the infant industries]: Min. and Sci. Press, vol. 119, No. 21, pp. 739–740, Nov. 22, 1919.

Does not agree with those who think the quicksilver industry is a declining one. On the contrary states that it is in its infancy and should be protected by tariff.

INGALLS, W. R., Industrial cooperation: Min. and Sci. Press, vol. 118, No. 26, pp. 877–884, June 28, 1919.

States his opinion in reference to the quicksilver industry that it would be far cheaper for our Government to buy from abroad the supply for several years and pay storage and interest charges than to establish a high protective tariff to keep alive our domestic industry.

INNES, MURRAY, Quicksilver in California: Eng. and Min. Jour., vol. 107, No. 2, p. 56, Jan. 11, 1919.

States that the decline in production in 1918 was due to the closing down of some of the smaller mines and the sudden drop in production of the New Idria mine.

INNES, MURRAY, Metallurgy of quicksilver: Eng. and Min. Jour., vol. 107, No. 2, p. 86, Jan. 11, 1919.

The most interesting development in the metallurgy of quicksilver in 1918 was the success of the rotary furnace of the cement-kiln type.

INNES, MURRAY, The American quicksilver industry [letter to Thomas Walker Page, of the U. S. Tariff Commission]: Eng. and Min. Jour., vol. 107, No. 20, pp. 878–879, May 17, 1919.

Urges renewed and substantial encouragement for the small operators.

KELLOGG, A. E., Cinnabar ore in Jackson County, Oreg.: Eng. and Min. Jour., vol. 107, No. 18, p. 787, 2 figs., May 3, 1919.

Describes the geology and history of the cinnabar ore deposits in the Gold Hill district.

KEW, W. S. W., Geology of a part of the Santa Ynez River district, Santa Barbara County, Calif. [cinnabar]: California Univ. Dept. Geology Bull., vol. 12, No. 1, p. 7, Nov. 20, 1919.

Cinnabar occurs in a hard brown mass which is exposed along a fault parallel with Santa Ynez River and has been mined in a small way for many years.

LANG, HERBERT, Simple tests of economic minerals [quicksilver ore]: Min. and Sci. Press, vol. 118, p. 21, Jan. 4, 1919.

Put the red particles of cinnabar on a clean sheet of iron and heat over the camp fire. If cinnabar they will pass off in gray smoke. This is conclusive.

LARSEN, E. S., The occurrence of cinnabar near Black Pine, Idaho: Idaho Univ. School of Mines, vol. 14, Bull. 2, pp. 65–67, January, 1919.

Describes the location, topography, geology, and mineralization of the quicksilver prospects in the Black Pine district.

LIVINGSTON, D. C., Tungsten, cinnabar, manganese, molybdenum, and tin deposits of Idaho [quicksilver]: Idaho Univ. School of Mines, vol. 14, Bull. 2, pp. 54–65, figs., contour and claim maps of Cinnabar district, January, 1919.

Describes the occurrence of quicksilver in Fern Creek district, Valley County, Idaho.

MCCASKEY, H. D., Quicksilver in 1916: U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 757–773, Feb. 19, 1919.

Gives uses and production of quicksilver and the resources, occurrences, and developments in Alaska, Arizona, California, Nevada, Oregon, Texas, and Washington.

MINERAL INDUSTRY, Quicksilver: Vol. 27, pp. 629–638, 1919.

Gives table of statistics of quicksilver in the United States from 1904 to 1918 and details of production during 1918 in California, Texas, Nevada, Oregon, and Idaho. "The most interesting development in the metallurgy of quicksilver during the year 1918 was the pronounced success of the rotary furnace of the cement-kiln type as introduced at the New Idria mine [California]." (P. 637.)

MINING AND SCIENTIFIC PRESS, Industrial cooperation: Vol. 118, No. 26, p. 869, June 28, 1919.

An editorial comment on W. R. Ingalls's article in the same number. Thinks that the suggestion to buy the cheaper Spanish quicksilver and store it as a reserve for the next war is poor political economy.

RANSOME, F. L., Quicksilver: U. S. Geol. Survey Bull. 666, pp. 211–219, 1919.

Reviews uses of quicksilver, composition of ores, metallurgy, form of ore bodies, and occurrences. Gives tables of statistics and discusses the future of the quicksilver industry in the United States.

SALT LAKE MINING REVIEW, Cinnabar deposits in Nevada: Vol. 21, No. 7, p. 43, July 15, 1919.

The Quicksilver Mines Co., of Reno, operating in Jersey Valley, south of Battle Mountain in Nevada, reported as opening large deposits of cinnabar ore.

SHARPLESS, F. F., The American quicksilver industry: Eng. and Min. Jour., vol. 108, No. 1, p. 24, July 5, 1919.

Suggests some questions in regard to the United States quicksilver industry which demand careful consideration from those who must decide its future.

SHARPLESS, F. F., The quicksilver industry: Min. and Sci. Press, vol. 119, No. 8, p. 259, Aug. 23, 1919.

States that his article in the Engineering and Mining Journal "was written with the hope that it might draw out stronger arguments for protection from those intimately acquainted with the industry than had yet been presented."

SOCIEDAD NACIONAL DE MINERÍA, Santiago de Chile, Sobre la industria minera del azogue en Italia i en los Estados Unidos: Bol. minero, vol. 31, No. 240, pp. 136–140, February, 1919.

States that Italy leads the countries producing mercury, and that the Italian Government has assumed the monopoly of its production and of its sale. Quotes the list of uses given by the U. S. Geol. Survey during 1917 and the production in the United States in 1917 as 36,351 flasks.

UDDEN, J. A., Anticlinal theory, as applied to some quicksilver deposits (abstract): Geol. Soc. America Bull., vol. 30, No. 1, p. 112, March, 1919.

"Accumulation seems to have been governed by conditions similar to those which result in the accumulation of oil and gas, with this difference, that it occurs in favorable structures only in places where there has been fissuring or intrusion of igneous material."

UDDEN, J. A., BAKER, C. L., and BÖSE, EMIL, Review of the geology of Texas [quicksilver]: Texas Univ. Bull. 44, 3d ed. (revised), pp. 126–127, 1 fig. (sketch map of localities of quicksilver ore in the Terlingua district), 1919.

Since 1900 quicksilver has been mined in the southern part of Brewster County, Tex. In nearly all the localities the quicksilver seems to have a structural relation to the formations similar to that of oil and gas.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN CALIFORNIA.

(MINES REPORT.)

By Charles G. Yale.[1]

INTRODUCTION.

In common with other metal-producing States of the Union, California showed a material reduction in the aggregate value of its metals in 1919, as compared with 1918, the reduction amounting to $8,985,909. By far the larger part of this loss was due to the falling off in the value of copper, which was $7,733,395 less than in 1918.

The decreased yield of metals in California, as allied to the exhaustion of deposits, was fully discussed in the report for 1918. The obvious reasons for decreased yield of most of the metals in 1919 were high cost and scarcity of skilled labor, lack of continuous power, increased cost of supplies, burden of war taxation, and general unfavorable conditions. Numerous mines were closed; most others curtailed operations to avoid increased costs; and scarcely any new mining enterprises were begun.

In the gold-mining industry, especially, many mines were closed and none were opened or reopened to take their places. Nevertheless, the yield of gold in California increased in 1919 instead of decreasing. This increase was due entirely to the operations of the gold dredges. Of the total gold produced in the State in 1919, 52 per cent came from deep mines and 48 per cent from placers, and of the total output of placer gold the dredges produced 96 per cent, or 46 per cent of the entire gold yield of the State. The yield of gold from deep mines was $27,295 less than in 1918 and that from placers was $194,297 more than in 1918. The siliceous ore from the deep quartz gold mines produced 98 per cent of the deep-mine gold. The leading gold-producing county of the State, Yuba, is almost entirely a gravel-mining county; in this county there are more and larger dredges than elsewhere, and they produced $435,893 more in gold in 1919 than in 1918, yielding altogether 99 per cent of the total output of the county. This gravel-mining county exceeded by $1,214,420 the output of gold of Nevada County, which led the deep-mine gold producers of the State.

The cost of producing an ounce of gold at the deep mines has greatly increased in the last few years. The president of one of the best developed and equipped and the most productive of the deep gold mines of the State, says in his report:

> The cost of producing an ounce of gold at our mine was $18.04 in 1919, as compared with $9.51 in 1913, a disparity due in some measure to a lower grade of ore but chiefly to the adverse conditions now confronting the gold-mining industry. Unfortunately,

[1] The writer is indebted to James M. Hill, of the United States Geological Survey, for material assistance in the preparation of certain portions of this chapter.

it can not be said that there is much likelihood of early improvement in the situation; for a change for the better, unless an increased price should be obtained for new gold, can only come about through a reduction of expenses, following upon lower prices for all the items entering into the production of gold.

These figures relate to a typical deep gold mine. The conditions in the placer mining industry are much the same. The annual reports of a large dredging company, which operates 11 dredges, 9 in one field, 2 in another, and which dredged 20,485,530 cubic yards of gravel in 1919, with a gross recovery of $1,775,124, show the following comparative figures of gross return, cost, and net return per cubic yard of gravel, in cents: 1914–1917, inclusive, gross recovery 9.16, cost 4.57, net return 4.59; 1919, gross recovery 8.66, cost 6.41, net return 2.25. According to the company's report the remaining proved dredging ground owned amounts to 160,000,000 cubic yards, or enough to permit operation for eight years. A reduction in cost of operation due either to a fall in prices or to relief by the Government, would permit the dredging of 40,000,000 cubic yards additional.

In the five Mother Lode counties of the State, one of which contains the deepest gold mines, 45.5 per cent of the total ore milled or shipped in the State was treated. This is 12 per cent more than in 1918. The output of ore in these counties decreased materially in 1919, being 65,129 tons less than in 1918, but the value of total recovery per ton in gold and silver was $6.27 in 1919, as compared with $4.27 in 1918. The average value of all metals from ores of the State in 1919 was $8.24 a ton, as compared with $9.32 a ton in 1918. From ordinary ore sent to gold and silver mills the recovery in batteries, plates, etc., was $5.93 a ton in gold and $0.118 in silver, compared with $4.31 in gold and $0.073 in silver in 1918. The recovery from the concentrates treated was $38.64 a ton in gold and $4.67 a ton in silver, as compared with $22.36 in gold and $3.05 in silver in 1918. The average value of old tailings treated in 1919 was $1.52 a ton in gold and $0.946 in silver.

There were altogether 650 mines in California which reported production in 1919, or 53 less than in 1918. The number of distinctively deep gold mines producing in 1919 was 303, or 43 more than in 1918; and the number of all kinds of deep mines—gold, silver, copper, lead, and zinc—was 370, or 18 less than in 1918, and from all these more or less gold was obtained. The number of producing placers in 1919 was 280.

Many old miners and prospectors have been at work in the foothill and valley counties, and the gold obtained by them in small quantities in various localities amounted to considerable in the aggregate. These small quantities are obtained in "crevicing" and from deposits along the rivers, gulches, and creeks, river sands, and small gravel bars. Some gold is obtained also in pocket seams and at idle mines where no regular work is being carried on. Richer spots are "gouged," and the selected or sorted ore is crushed and shipped in small lots. Numbers of the men doing this work do not own the mines but either mine by permission of the owners or go upon idle claims where there are no watchmen or caretakers. There are many hundreds of such mines, where, as no assessment work is necessary, the owners do nothing whatever and do not go near the properties from one year's end to another.

The water supply of California was scant in 1919, and the water season short. This condition affected not only the various forms of gravel mines but the deep mines as well. The companies supplying

hydroelectric power to the mills, pumps, and hoists of deep mines and to the dredges were compelled to restrict the use of such power very greatly, allowing electric power only for certain hours daily instead of permitting unlimited use as in ordinary times. The cost of power was also materially increased, so that its use became very burdensome to the miners. Under such conditions full-time work could not well be done in any branch of the industry.

The other metals aside from gold produced in the State were very adversely affected by the conditions prevailing in 1919. The value of silver produced was $187,660, or 13 per cent less than in 1918. Copper declined 25,942,153 pounds, or 54 per cent, in quantity and $7,733,395, or 66 per cent, in value. Lead declined 9,803,782 pounds, or 73 per cent, in quantity, and $760,297, or 80 per cent, in value. Zinc declined 5,088,403 pounds, or 91 per cent, in quantity and $471,559, or 93 per cent, in value. The value of all metals produced in California in 1919 declined $8,985,909, or 29 per cent, as compared with 1918.

The details of mining work in the Mother Lode counties are given in the section on production by counties. A condensed statement is given in the following table:

Gold and silver produced at mills in Mother Lode counties in California in 1919.

County.	Total ore treated (short tons).	Gold and silver recovered in bullion.		
		Gold.	Silver (fine ounces).	Average value in gold and silver per ton of ore.
Amador	455,333	$2,071,613	20,911	$4.603
Calaveras	162,903	912,764	5,981	5.644
Eldorado	707	11,561	132	16.561
Mariposa	32,070	222,445	2,766	7.033
Tuolumne	129,660	102,738	1,481	.805
	780,673	3,321,121	31,271	4.299

County.	Concentrates produced.				Value of total recovery.	
	Quantity (short tons).	Gold.	Silver (fine ounces).	Average value in gold and silver per ton of concentrates.	Total.	Average value per ton of ore.
Amador	9,209	$738,007	8,217	$81.139	$2,842,243	$6.242
Calaveras	4,838	380,876	3,338	79.498	1,304,077	8.005
Eldorado					11,709	16.562
Mariposa	496	29,562	918	61.673	256,133	7.987
Tuolumne	7,855	366,872	8,400	47.903	480,677	3.707
	22,398	1,515,317	20,873	68.697	4,894,839	6.270

A comparison of this table with the corresponding one for 1918 shows a total decrease of ore treated at gold and silver mills in the five Mother Lode counties in 1919 of 65,129 tons. A decrease in the quantity of ore treated is evident in all these counties except Tuolumne and Eldorado.

In the Mother Lode counties 780,673 tons of ore was treated in 1919 at gold and silver mills and 22,398 tons was treated at concentrating plants and yielded in gold and silver $4,894,839, or an average of $6.270 a ton, as compared with 845,802 tons in 1918, yielding $4,334,061, or an average of $4.268 a ton; 1,236,903 tons in 1917, yielding $5,130,682, or an average of $4.148 a ton; 1,393,788 tons in 1916, yielding $5,853,618, or an average of $4.199 a ton; 1,521,847 tons in 1915, yielding $6,349,772, or an average of $4.17 a ton; 1,243,529 tons in 1914, yielding $5,075,522, or an average of $4.08 a ton; 1,242,343 tons in 1913, yielding $4,728,450, or an average of $3.81 a ton; and 1,299,988 tons in 1912, yielding $4,803,935, or an average of $3.69 a ton.

The average value in gold and silver bullion recovered in batteries, plates, etc., of the mills was $4.299 a ton from 780,673 tons of siliceous ore, as compared with $3.176 a ton in 1918. The average value of the gold and silver recovered from the 22,398 tons of concentrates from this ore was $68.697 a ton, as compared with $34.62 in 1918, $40.35 in 1917, and $56.83 in 1916. The average total recovery, $6.27 a ton, was very much higher than for many years and accounts for the total increase in value of gold and silver in these Mother Lode counties, notwithstanding a lessened ore output.

The total quantity of ore treated at gold and silver mills from the deep mines of the State in 1919 was 1,070,010 short tons, which was 344,634 tons less than in 1918. Of the total ore milled (exclusive of ore sent to concentrating plants), 73 per cent came from the Mother Lode counties. Amador, the largest producer of ore and gold in the Mother Lode counties, produced about 40 per cent of the total quantity of ore milled in the State in 1919 and 55 per cent of the ore milled in the Mother Lode counties.

Crude ore sold or treated in California in 1919, in short tons.

County.	Siliceous ores.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc ores.	Total.
Amador	455,333					455,333
Butte	390					390
Calaveras	162,903	60,638				223,541
Eldorado	707					707
Fresno	193					193
Imperial	1,178					1,178
Inyo	6,581	102	13,311		684	20,678
Kern	17,083					17,083
Lassen	29					29
Madera	1,018	514				1,532
Mariposa	32,070					32,070
Modoc	700					700
Mono	2,991	2	56			3,049
Nevada	316,044					316,044
Orange	56					56
Placer	11,344	29				11,373
Plumas	4,007	324,424				328,431
Riverside	10	55				65
Sacramento	1					1
San Bernardino	28,856	607	2,285			31,748
San Diego	20					20
Shasta	8,510	97,542				106,052
Sierra	30,924					30,924
Siskiyou	1,326	2,261				3,587
Trinity	208	259				467
Tuolumne	129,660					129,660
	[a]1,212,142	486,433	15,652		684	1,714,911
Decrease	326,818	421,626	23,094	297	16,665	788,500
Average value per ton in gold and silver	$7.518	$1.065	$14.679		$16.595	$5.756

[a] Includes 23,281 tons of silver ore.

Value of ore mined and treated in California in 1919.

Class.	Ore (short tons).	Total value.		Average value per ton.	
		In gold and silver.	In all metals.	In gold and silver.	In all metals.
Siliceous	[a]1,212,142	$9,112,260	$9,116,692	$7.518	$7.521
Copper	486,433	518,283	4,556,693	1.065	9.367
Lead	15,652	229,761	424,836	14.679	27.143
Zinc	684	11,351	39,326	16.595	57.494
	1,714,911	9,871,655	14,137,547	5.756	8.243

[a] Includes 23,281 tons of silver ore carrying $21 in gold and $54,313 in silver.

The value of all metals obtained from the 1,714,911 tons of ore mined in California in 1919 (not including placer-mine output) was $14,137,547, an average of $8.24 a ton. In 1918 the value was $23,319,119, an average of $9.32; in 1917 the figures were, respectively, $28,589,495 and $9.52; in 1916, $31,154,122 and $9.77; in 1915, $23,636,028 and $7.87; in 1914, $16,610,509 and $6.74; in 1913, $17,954,941 and $7.19; in 1912, $17,716,357 and $6.71; in 1911, $16,167,193 and $5.49; and in 1910, $18,109,008 and $6.71.

Gold and silver produced in California in 1919, by methods of treatment.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
	Quantity.	Gold.	Silver.		Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*	*Short tons.*		*Fine ounces.*
Amador	428,053	$2,012,780	20,250	200	9,208	$736,007	8,199
Butte	390	2,921	21	.....	.....	.....	.....
Calaveras	162,676	911,792	5,899	53,458	8,804	387,426	8,441
Eldorado	622	11,396	131	.....	.....	.....	.....
Fresno	193	2,853	36	.....	.....	.....	.....
Imperial	.....	.....	.....	.....	.....	.....	.....
Inyo	391	4,677	117	8,736	300	28,250	3,198
Kern	17,008	148,420	4,669	.....	.....	.....	.....
Lassen	29	300	45	.....	.....	.....	.....
Madera	1,018	14,599	283	.....	20	1,460	70
Mariposa	32,079	222,445	2,766	.....	496	29,562	918
Modoc	700	6,478	348	.....	.....	.....	.....
Mono	1,886	19,005	15,603	.....	.....	.....	.....
Nevada	316,027	2,446,388	56,264	.....	5,253	499,106	3,807
Orange	36	1,447	26	.....	.....	.....	.....
Placer	11,344	82,359	1,474	.....	100	6,821	706
Plumas	4,007	26,476	204	324,298	20,126	40,210	155,807
Riverside	10	198	1	.....	.....	.....	.....
Sacramento	1	558	5	.....	.....	.....	.....
San Bernardino	2,784	12,341	215	2,160	65	1,493	10,516
San Diego	20	1,470	11	.....	.....	.....	.....
Shasta	8,506	25,425	244	11,027	2,178	4,775	26,788
Sierra	30,924	258,561	2,351	.....	.....	.....	.....
Siskiyou	1,326	20,445	223	.....	.....	.....	.....
Trinity	208	5,684	59	.....	.....	.....	.....
Tuolumne	49,781	102,738	1,481	79,879	7,855	366,872	8,400
	1,070,010	6,341,756	112,726	479,758	54,405	2,101,982	226,850
Average value per ton	.....	$5.927	$0.118	.....	.....	$38.636	$4.670

Gold and silver produced in California in 1919, by methods of treatment—Continued.

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Amador	1	$2,000	18	27,079	$58,833	661
Butte						
Calaveras	7,407	10,971	16,327			
Eldorado				85	165	1
Fresno						
Imperial				1,178		7,685
Inyo	11,262	35,868	168,930	289	765	1,104
Kern	75	1,304	2,818			
Lassen						
Madera	514	1,646	1,165			
Mariposa						
Modoc						
Mono	322	2,013	33,568	841	8,410	434
Nevada				17	8,289	1,082
Orange	20	41	401			
Placer	29	227	37			
Plumas	126	412	904			
Riverside	55	15	369			
Sacramento						
San Bernardino	3,397	22,031	337,449	23,407	3,904	33,710
San Diego						
Shasta	86,519	57,527	119,504			
Sierra						
Siskiyou	2,261	4,010	13,320			
Trinity	259	710	202			
Tuolumne						
	112,247	138,775	695,012	52,896	80,366	44,677
Average value per ton		$1.236	$6.934		$1.519	$0.946

In 1919 California gold and silver mills and concentrating plants treated 1,549,768 tons of ore, yielding altogether $8,443,738 in gold and 339,576 fine ounces of silver, valued at $380,325, a total value of $8,824,063 in gold and silver, and an average value of $5.69 a ton in both metals. The average value in 1918 was $4.27; in 1917 it was $4.46; in 1916, $5.04; in 1915, $5.56; in 1914, $5.44; in 1913, $5.57; in 1912, $5.08; in 1911, $4.64; and in 1910, $5.25.

The bullion recovered in 1919 in mills amounted to $6,341,756 in gold and 112,726 fine ounces of silver, valued at $126,253, a total of $6,468,009 in gold and silver and an average of $6.04 a ton in both metals. From 1,070,101 tons of gold milling ore and 479,758 tons of concentrating ore 54,405 tons of concentrates were obtained, containing $2,101,982 in gold and 226,850 fine ounces of silver, valued at $254,072, a total yield of $2,356,054, or an average value of $43.31 a ton of concentrates.

Of the smelting ores, 112,247 short tons was treated and yielded $138,775 in gold and 695,012 fine ounces of silver, valued at $778,413. The total yield in gold and silver was $8.17 a ton.

Tailings and slag amounting to 52,896 tons were treated, which yielded $80,366 in gold and 44,677 fine ounces of silver, valued at $50,038, the total value in gold and silver being $130,404, an average of $2.47 a ton.

PRODUCTION.

SUMMARY.

Gold, silver, copper, lead, and zinc produced in California, 1910–1919.

Year.	Number mines producing.	Ore.	Gold.[a]	Silver.[b]	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1910	1,079	2,697,885	$19,715,440	1,840,085	48,700,756	2,870,977	.....	$27,020,405
1911	1,181	2,797,261	19,738,908	1,270,445	36,316,136	1,398,111	2,807,035	25,174,677
1912	1,041	2,641,497	19,713,478	1,300,136	33,451,672	1,144,731	4,345,591	26,383,946
1913	796	2,495,958	20,406,958	1,378,399	34,575,007	3,514,342	1,057,485	25,812,487
1914	658	2,465,485	20,053,496	1,471,859	30,507,692	4,251,923	389,471	25,710,645
1915	608	3,002,779	22,442,296	1,678,756	40,751,625	4,579,245	13,094,032	32,263,844
1916	589	3,187,642	21,410,741	2,564,354	55,897,118	12,407,493	15,256,485	39,749,263
1917	490	3,003,250	20,087,504	1,775,431	48,153,139	21,868,628	10,872,716	37,685,985
1918	703	2,503,411	16,528,953	1,427,711	47,674,660	13,372,049	5,561,393	31,187,807
1919	650	1,714,911	16,695,955	1,107,189	21,732,507	3,568,267	472,990	22,201,898
Increase or decrease in 1919	−53	−788,500	+167,002	−320,522	−25,942,153	−9,803,782	−5,088,403	−8,985,909

[a] Includes placer gold. [b] Includes placer silver.

The production of deep mines in 1919 may be classified by chief metallic product, as follows: Gold, 303; copper, 42; lead, 23; zinc, 2. Of the placer mines 79 were surface or sluicing, 34 less than in 1918; 86 were hydraulic, 1 less than in 1918; 69 were drift, 3 more than in 1918; and 46 were dredges, 3 less than in 1918. Of the deep mines there were 43 more gold mines, 20 less copper, 33 less lead, 6 less copper-lead (none in 1919), and 2 less zinc; there were, therefore, 18 less deep mines producing in 1919 than in 1918. The dredges are enumerated by the number of boats at work, some companies operating only one and others several.

Mine production of gold, silver, copper, lead, and zinc in California in 1919.

County.	Ore treated.	Deep-mine gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Fine ounces.*	
Amador	455,333	135,915.37	$2,809,620	5,363.43	$110,872	141,278.80	$2,920,492
Butte	390	141.30	2,921	18,158.81	375,376	18,300.11	378,297
Calaveras	223,541	63,380.39	1,310,189	11,628.62	240,385	75,009.01	1,550,574
Del Norte	.....	.....	.....	41.94	867	41.94	867
Eldorado	707	559.26	11,561	897.84	18,560	1,457.10	30,121
Fresno	193	138.02	2,853	129.99	2,687	268.01	5,540
Humboldt	.....	.....	.....	786.58	16,260	786.58	16,260
Imperial and San Diego[a]	1,198	71.11	1,470	.....	.....	71.11	1,470
Inyo	20,678	3,364.97	69,560	.....	.....	3,364.97	69,560
Kern	17,083	7,242.90	149,724	41.84	865	7,284.74	150,589
Lassen and Modoc[a]	729	327.88	6,778	.....	.....	327.88	6,778
Madera	1,532	856.48	17,705	.....	.....	856.48	17,705
Mariposa	32,070	12,190.84	252,007	67.01	1,385	12,257.85	253,392
Merced, San Joaquin, and Stanislaus[a]	.....	.....	.....	7,859.54	162,471	7,859.54	162,471
Mono	3,049	1,423.58	29,428	.....	.....	1,423.58	29,428
Nevada	316,044	142,889.25	2,953,783	1,331.71	27,529	144,220.96	2,981,312
Orange	56	71.98	1,488	.....	.....	71.98	1,488
Placer	11,373	4,325.06	89,407	3,928.15	81,202	8,253.21	170,609
Plumas	328,431	3,245.87	67,098	798.28	16,502	4,044.15	83,600
Riverside	65	10.30	213	.....	.....	10.30	213
Sacramento	1	26.99	558	82,897.08	1,713,635	82,924.07	1,714,193
San Bernardino	31,748	1,923.83	39,769	.....	.....	1,923.83	39,769
Shasta	106,052	4,243.80	87,727	14,055.65	290,556	18,299.45	378,283
Sierra	30,924	12,507.89	258,561	2,061.31	42,611	14,569.20	301,172
Siskiyou	3,587	1,183.01	24,455	9,775.14	202,070	10,958.15	226,525
Trinity	467	309.31	6,394	25,740.34	532,100	26,049.65	538,494
Tuolumne	129,660	22,717.38	469,610	68.26	1,411	22,785.64	471,021
Yuba	.....	.....	.....	202,968.53	4,195,732	202,968.53	4,195,732
	1,714,911	419,066.77	8,662,879	388,600.05	8,033,076	807,666.82	16,695,955
Total, 1918	2,503,411	420,387.17	8,690,174	379,200.93	7,838,779	799,588.10	16,528,953
Increase or decrease, 1919	−788,500	−1,320.40	−27,295	+9,399.12	+194,297	+8,078.72	+167,002

[a] Yield of single mine in each county combined to avoid disclosing individual output.

Mine production of gold, silver, copper, lead, and zinc in California in 1919—Contd.

County.	Deep-mine silver.		Placer silver.		Total silver.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*		*Fine ounces.*	
Amador	29,128	$32,623	563	$631	29,691	$33,254
Butte	21	24	1,685	1,887	1,706	1,911
Calaveras	30,667	34,347	1,365	1,529	32,032	35,876
Del Norte			5	6	5	6
Eldorado	132	148	117	131	249	279
Fresno	36	40	24	27	60	67
Humboldt			120	134	120	134
Imperial and San Diego [a]	7,696	8,619			7,696	8,619
Inyo	173,349	194,151			173,349	194,151
Kern	7,487	8,386	14	16	7,501	8,402
Lassen and Modoc [a]	394	440			394	440
Madera	1,518	1,700			1,518	1,700
Mariposa	3,684	4,126	12	13	3,696	4,139
Merced, San Joaquin, and Stanislaus [a]			785	879	785	879
Mono	49,605	55,558			49,605	55,558
Nevada	61,153	68,491	214	240	61,367	68,731
Orange	427	478			427	478
Placer	2,217	2,483	588	658	2,805	3,141
Plumas	156,914	175,744	91	102	157,005	175,846
Riverside	370	415			370	415
Sacramento	5	6	4,705	5,270	4,710	5,276
San Bernardino	381,890	427,717			381,890	427,717
Shasta	146,536	164,120	1,502	1,682	148,038	165,802
Sierra	2,351	2,633	289	324	2,640	2,957
Siskiyou	13,543	15,168	1,680	1,881	15,223	17,049
Trinity	261	292	3,196	3,580	3,457	3,872
Tuolumne	9,881	11,067	8	9	9,889	11,076
Yuba			10,961	12,276	10,961	12,276
Total, 1918	1,079,265	1,208,776	27,924	31,275	1,107,189	1,240,051
	1,397,802	1,397,802	29,909	29,909	1,427,711	1,427,711
Increase or decrease	−318,537	−189,026	−1,985	+1,366	−320,522	−187,660

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Amador							$2,953,746
Butte							380,208
Calaveras	2,047,804	$380,892			168,849	$12,326	1,979,668
Del Norte							873
Eldorado							30,400
Fresno							5,607
Humboldt							16,394
Imperial and San Diego [a]							10,089
Inyo	157,770	29,345	3,400,901	$180,248	223,483	16,314	489,618
Kern							158,991
Lassen and Modoc [a]							7,218
Madera	114,338	21,267					40,672
Mariposa							257,531
Merced, San Joaquin, and Stanislaus [a]							163,350
Mono	2,425	451	13,617	722			86,159
Nevada	3,180	591	27,816	1,474			3,052,108
Orange			3,280	174			2,140
Placer	5,673	1,055					174,805
Plumas	10,859,885	2,019,939					2,279,385
Riverside	6,700	1,246	14,853	787			2,661
Sacramento							1,719,469
San Bernardino	252,024	46,876	107,800	5,713			520,075
Shasta	7,625,658	1,418,372			80,658	5,888	1,968,345
Sierra							304,129
Siskiyou	629,450	117,078					360,652
Trinity	27,600	5,134					547,500
Tuolumne							482,097
Yuba							4,208,008
Total, 1918	21,732,507	4,042,246	3,568,267	189,118	472,990	34,528	22,201,898
	47,674,660	11,775,641	13,372,049	949,415	5,561,393	506,087	31,187,807
Increase or decrease	−25,942,153	−7,733,395	−9,803,782	−760,297	−5,088,403	−471,559	−8,985,909

[a] Yield of single mine in each county combined to avoid disclosing individual output.

GOLD.

The total mine production of gold in California in 1919 was 807,666.82 fine ounces, valued at $16,695,955, an increase of 8,078.72 fine ounces, valued at $167,002, over the production in 1918. That there should be any increase at all under existing adverse conditions is a matter of congratulation to the gold miners of California. The deep mines of the State yielded 419,066.77 fine ounces of gold, valued at $8,662,879, which was a decrease of 1,320.40 ounces, valued at $27,295. Of the deep-mine gold 98 per cent was derived from siliceous ore, about 1.5 per cent from copper ore, and less than 1 per cent from lead ore and zinc ore.

The yield of placer-mine gold increased 9,399.12 fine ounces in quantity and $194,297 in value. The dredges of the State yielded $284,992 more gold in 1919 than in 1918. From 1898, when gold dredging began in California, to the end of 1919 the total output of gold from that source has been $110,335,831. Since 1898 the Oroville or Feather River dredging field, in Butte County, has yielded $30,970,830, not including $2,422,496 derived in the last 10 years from adjacent fields in the same county; from 1903 to 1919, inclusive, the Marysville or Feather River field, in Yuba County, produced $36,055,026 in gold; and since 1902 the Folsom or American River field, in Sacramento County, has produced $25,238,659 in gold. Dredges have also been operated in several smaller fields in the State.

The output of placer gold in 1919 in California was 388,600.05 fine ounces, valued at $8,033,076. The placer mines produced 48 per cent of the gold yield in 1919 and the deep mines 52 per cent, as compared with 47 per cent for the placers and 53 per cent for the deep mines in 1918. The dredges produced 46 per cent of the total gold from all sources in 1919. Of the total placer gold the dredges produced 96 per cent, the hydraulic mines about 2 per cent, the drift mines 1 per cent, and the sluicing mines less than 1 per cent. The larger dredging fields are at Oroville, Butte County; Folsom, Sacramento County; and Marysville, Yuba County; but dredges are also operated in nine other counties—1 in Amador, 2 in Calaveras, 1 in Merced, 1 in Placer, 1 in San Joaquin, 5 in Shasta, 2 in Siskiyou, 1 in Stanislaus, and 4 in Trinity. The Yuba County dredges, 12 in number, made the largest output of gold in 1919, the value being $4,185,926, an increase of $435,893. Sacramento County, with 10 dredges at work, made an output of $1,712,705, an increase of $22,426. In Butte County (including Oroville and the "outside districts") 6 dredges produced $361,604, or $264,406 less than in 1918.

Of the 32 counties producing gold 10 yielded no placer gold and 6 yielded no gold from deep mines. Five counties produced more than $1,000,000 each in gold in 1919, as follows: Yuba, $4,195,732; Nevada, $2,981,312; Amador, $2,920,492; Sacramento, $1,714,193; and Calaveras, $1,550,574. The leading hydraulic mining county was Trinity; the largest producer of gold from surface or sluicing placers was Butte; the largest producer of gold from dredges was Yuba; and the largest from drift mines was Placer. The largest increase in gold in 1919 was made in Calaveras County ($679,311), which was followed by Yuba ($427,799), Tuolumne ($196,693), Trinity ($93,765), Sacramento ($19,469), Sierra ($11,804); San Bernardino ($10,544), Madera ($10,122), and Humboldt ($8,232). The counties that showed a decreased output of gold in 1919, as compared with 1918,

were Amador ($328,893), Butte ($267,678), Shasta ($165,226), Kern ($95,538), Nevada ($89,141), Mariposa ($84,290), Siskiyou ($67,702), Placer ($59,581), Plumas ($41,607), and Inyo ($30,680).

Mine production of gold in California in 1919, in fine ounces.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc ores.	Total.	
Amador	5,363.43	135,915.37					135,915.37	141,278.80
Butte	18,158.81	141.30					141.30	18,300.11
Calaveras	11,628.62	62,579.83	800.56				63,380.39	75,009.01
Del Norte	41.94							41.94
Eldorado	897.84	559.26					559.26	1,457.10
Fresno	129.99	138.02					138.02	268.01
Humboldt	786.58							786.58
Inyo		1,622.94	2.66	1,733.95		5.42	3,364.97	3,364.97
Kern	41.84	7,242.90					7,242.90	7,284.74
Lassen		14.51					14.51	14.51
Madera		776.85	79.63				856.48	856.48
Mariposa	67.01	12,190.84					12,190.84	12,257.85
Merced, San Joaquin, and Stanislaus [a]	7,859.54							7,859.54
Modoc		313.37					313.37	313.37
Mono		1,383.09	.39	40.10			1,423.58	1,423.58
Nevada	1,331.71	142,889.25					142,889.25	144,220.96
Orange		71.98					71.98	71.98
Placer	3,928.15	4,314.08	10.98				4,325.06	8,253.21
Plumas	798.28	1,280.78	1,965.09				3,245.87	4,044.15
Riverside		9.57	.73				10.30	10.30
Sacramento	82,897.08	26.99					26.99	82,924.07
San Bernardino		1,836.56	76.92	10.35			1,923.83	1,923.83
San Diego		71.11					71.11	71.11
Shasta	14,055.65	1,271.92	2,971.88				4,243.80	18,299.45
Sierra	2,061.31	12,507.89					12,507.89	14,569.20
Siskiyou	9,775.14	989.03	193.98				1,183.01	10,958.15
Trinity	25,740.34	274.96	34.35				309.31	26,049.65
Tuolumne	68.26	22,717.38					22,717.38	22,785.64
Yuba	202,968.53							202,968.53
	388,600.05	411,139.78	6,137.17	1,784.40		5.42	419,066.77	807,666.82
Total, 1918	379,200.93	[b]400,912.60	15,443.97	3,988.75	21.58	20.27	420,387.17	799,588.10
Increase or decrease	+9,399.12	+10,227.18	−9,306.80	−2,204.35	−21.58	−14.85	−1,320.40	+8,078.72

[a] Yield of single mine in each county combined to avoid disclosing individual output.
[b] Includes 43.93 ounces from silver ores.

Value and source of placer gold mined in California in 1919.

County.	Hydraulic.	Dredging.	Drift.	Surface placers.	Total.
Amador	$9,068	$95,524	$5,932	$348	$110,872
Butte		361,604	7,130	6,642	375,376
Calaveras		232,258	3,259	4,868	240,385
Del Norte				867	867
Eldorado			16,354	2,206	18,560
Fresno				2,687	2,687
Humboldt	16,260				16,260
Kern				865	865
Mariposa				1,385	1,385
Merced, San Joaquin, and Stanislaus [a]		162,471			162,471
Nevada	17,833		4,311	5,385	27,529
Placer		48,000	31,094	2,108	81,202
Plumas	6,843		6,584	3,075	16,502
Sacramento		1,712,705	930		1,713,635
Shasta		290,008		548	290,556
Sierra	33,436		3,166	6,009	42,611
Siskiyou	49,643	148,920	1,137	2,370	202,070
Trinity	51,749	479,503		848	532,100
Tuolumne			972	439	1,411
Yuba		4,185,926	4,472	5,334	4,195,732
	184,832	7,716,919	85,341	45,984	8,033,076

[a] Yield of single dredge in each county combined to avoid disclosing individual output.

The gold recovered from siliceous ore and tailings in California in 1919 was as follows: By amalgamation, 308,638 fine ounces, by cyanidation, 43,099 fine ounces, a large part of which was from the treatment of concentrates; from concentrates and ore sent to smelters 67,330 fine ounces. These figures are only approximate, as many small operators keep no separate accounts and even the larger companies do not always segregate the quantity of gold obtained by methods of treatment. This is especially the condition where larger mills amalgamate in the batteries and on the plates and pass the tailings and concentrates direct to the cyanide plants. The recovery of some of the gold is due to the use of the flotation system, but this has not been considered in the above segregation of methods of treatment of the ore.

The 280 productive placer mines in California in 1919 yielded gold valued at $8,033,076 and 27,924 fine ounces of silver, valued at $31,275, a total of $8,064,351. The increase in placer gold was $194,297, and the increase in value of silver was $1,366. In production of gold the dredges showed an increase of $284,992, the hydraulic mines a decrease of $28,397, the drift mines a decrease of $23,079, and the surface or sluicing mines a decrease of $39,219.

SILVER.

The deep-mine production of silver in California in 1919 was 1,079,265 fine ounces, valued at $1,208,776, a decrease in quantity of 318,537 ounces and in value of $189,026. The larger portion of the silver, 695,012 fine ounces, valued at $778,413, was derived from crude smelting ore. Siliceous ores yielded 547,541 fine ounces, of which 48,494 ounces was recovered from strictly silver ores. The largest output of silver in 1919 was made by San Bernardino County mines, which produced 361,974 fine ounces from siliceous ores, 8,148 fine ounces from copper ores, and 11,768 fine ounces from lead ores, a total of 381,890 ounces, valued at $427,717. Inyo was second in rank as a silver-producing county in 1919, supplying 173,349 fine ounces, valued at $194,151; Plumas County was third, with 157,005 fine ounces, valued at $175,846; and Shasta County was fourth, with 148,038 fine ounces, valued at $165,802. The silver obtained from refining crude placer bullion produced in 1919 was 27,924 fine ounces, of which Yuba County produced 10,961 ounces.

From 1,212,142 tons of siliceous ore in 1919 was derived 547,541 fine ounces of silver; from 486,433 tons of copper ore, 349,480 fine ounces of silver; from 15,652 tons of lead ore, 172,209 fine ounces of silver; and from 684 tons of zinc ore, 10,035 fine ounces of silver. The decrease in the output of silver in the State may be attributed to the lessened output of silver-bearing copper ores, due mainly to the closing of mines and smelters in Shasta County, which for many years has led all other counties of California in silver production.

The silver recovered from the ore and tailings treated in 1919 was as follows: By amalgamation, 81,597 fine ounces; by cyanidation, 118,543 fine ounces (part of which was recovered from concentrates); and by direct smelting, 879,125 fine ounces.

Mine production of silver in California in 1919, by sources, in fine ounces.

County.	Placers.	Deep mines.						Grand total.
		Siliceous ores.	Copper ores.	Lead ores.	Copper-lead ores.	Zinc ores.	Total.	
Amador	563	29,128					29,128	29,691
Butte	1,685	21					21	1,706
Calaveras	1,365	9,319	21,348				30,667	32,032
Del Norte	5							5
Eldorado	117	132					132	249
Fresno	24	36					36	60
Humboldt	120							120
Imperial and San Diego		7,696					7,096	7,696
Inyo		2,987	2,548	157,779		10,035	173,349	173,349
Kern	14	7,487					7,487	7,501
Lassen and Modoc [a]		394					394	394
Madera		353	1,165				1,518	1,518
Mariposa	12	3,684					3,684	3,696
Merced, San Joaquin, and Stanislaus [a]	785							785
Mono		46,891	52	2,662			49,605	49,605
Nevada	214	61,153					61,153	61,367
Orange		427					427	427
Placer	588	2,180	37				2,217	2,805
Plumas	91	203	156,711				156,914	157,005
Riverside		1	369				370	370
Sacramento	4,705	5					5	4,710
San Bernardino		361,974	8,148	11,768			381,890	381,890
Shasta	1,502	956	145,580				146,536	148,038
Sierra	289	2,351					2,351	2,640
Siskiyou	1,680	223	13,320				13,543	15,223
Trinity	3,196	59	202				261	3,457
Tuolumne	8	9,881					9,881	9,889
Yuba	10,961							10,961
Total, 1918	27,924	547,541	[b] 349,480	172,209		10,035	1,079,265	1,107,189
	29,909	228,332	[c] 669,711	448,547	12,820	38,392	1,397,802	1,427,711
Increase or decrease	−1,985	+319,209	−320,231	−276,338	−12,820	−28,357	−318,537	−320,522

[a] Yield of single mine in each county combined to avoid disclosing individual output.
[b] Includes 48,494 ounces from silver ore.
[c] Includes 47,452 ounces from silver ore.

COPPER.

The mine production of copper in California in 1919 was 21,732,507 pounds, valued at $4,042,246, a decrease of 25,942,153 pounds in quantity and of $7,733,395 in value from the production of 1918, which was 47,674,660 pounds, valued at $11,775,641. The decrease was due largely to the closing of the Mammoth mine in Shasta County and the curtailed operations of the Mountain Copper Co. in Shasta County and of the Calaveras and Penn companies in Calaveras County. Plumas County took first rank in production of copper in 1919, supplying 10,859,885 pounds, valued at $2,019,939; Shasta County produced 7,625,658 pounds, valued at $1,418,372, and Calaveras County produced 2,047,804 pounds, valued at $380,892. Other counties producing copper, named in the order of their output, were Siskiyou, San Bernardino, Inyo, Madera, Trinity, Riverside, Placer, Nevada, and Mono.

A total of 486,433 tons of copper ore was produced by 43 mines in the State in 1919, as compared with 908,059 tons in 1918, a decrease of 421,626 tons. The copper ore yielded $518,283 in gold and silver, or at the rate of $1.065 a ton in the precious metals, and had a total recoverable value of $4,556,693, an average of $9.367 a ton.

LEAD.

The mine production of lead in California in 1919 was 3,568,267 pounds, valued at $189,118, as compared with 13,372,049 pounds, valued at $949,415, in 1918. The lead ore also yielded 1,784.40 fine ounces of gold, valued at $36,887, and 172,209 fine ounces of silver, valued at $192,874. The total value of the output from the lead-mining industry in the State in 1919 in lead, gold, and silver was $424,836, as compared with $1,516,249 in 1918. This refers to ores classified as lead ores only.

ZINC.

The mine production of recoverable zinc in California in 1919 was 472,990 pounds, valued at $34,528, as compared with 5,561,393 pounds, valued at $506,087, in 1918, a decrease of 5,088,403 pounds in quantity and of $471,559 in value. The output came from Inyo, Calaveras, and Shasta counties, named in the order of quantity produced. No zinc was produced from mines in San Bernardino County.

PRODUCTION BY COUNTIES.

AMADOR COUNTY.

Amador County continued in 1919 to lead all the other counties of California in quantity of ore produced and treated, 455,333 tons, exceeding the next county in rank, Plumas, by 126,902 tons; the decrease in quantity in 1919 amounted to 61,182 tons, as compared with 1918. The gold produced in Amador County in 1919 was valued at $2,920,492, the silver at $33,254. No output of copper was reported. There was 39 producing deep mines in the county in 1919 and 9 placers.

Of the total output of ore 428,053 tons was treated at gold and silver mills. From this milling ore $2,012,780 in gold and 20,250 ounces of silver were saved as bullion, and 9,208 tons of concentrates were obtained which yielded $736,007 in gold and 8,199 ounces in silver, valued at $9,183. The value of the total gold and silver from milling ore was $2,779,876, or $6.494 a ton. The 27,079 tons of old tailings re-treated yielded $58,833 in gold and 661 fine ounces of silver, valued at $740, a total of $59,573. The ore shipped to the smelter yielded $2,000 in gold and 18 ounces of silver, valued at $20. The placer gold produced in the county in 1919 was valued at $110,872, which was $124,475 less than in 1918. This decreased output of gold was due to a decline in output from dredging operations. In 1919 Amador was the third gold-producing county in the State, with $2,920,492 to its credit, being exceeded in rank by Yuba and Nevada counties.

Amador City is a productive camp in the county. The Bunker Hill Consolidated Mining Co., owner of the principal quartz mine there, did 2,454 feet of development work during 1919, which included sinking the shaft 423 feet deeper. The equipment consists of a 40-stamp amalgamating and concentrating mill, with 24 Frue vanners. The tailings of the mine are worked by the Darrow Leasing Co., which is equipped with rotating concentrating tables and a 10-ton cyanide plant. The Keystone mines have a 40-stamp amalgamating and concentrating mill, but the tailings are discarded. The Original

and 6 surface mines. From the placers, gold recovered by dredges in 1919 amounted to $232,258, an increase of $120,953, as compared with 1918; that from the drift mines was $3,259, or $1.368 less than in 1918; and that from the surface placers was $4,868, or $5,843 less than in 1918.

The average value per ton of 162,903 tons of milling ore treated at gold and silver mills in the county in 1919 was $8.005 in gold and silver, compared with $1.613 in 1918. This considerable increase in average value is in part explained by the fact that the Melones ore was of very low grade and when operated it reduced the average of the ore of the other mines. The total quantity of ore sold or treated in Calaveras County in 1919 was 223,541 tons, which yielded gold valued at $1,310,189, silver valued at $34,347, and 2,047,804 pounds of copper, valued at $380,892. The placer output was $240,385 in gold and $1,529 in silver. The total output of the county in gold, silver, and copper was $1,979,668.

During the year 162,676 tons of ore was treated at gold and silver mills, from which was obtained $911,792 in gold in bullion and $6,607 in silver. The total value in bullion was $918,399, or $5.646 a ton. From the 162,676 tons of ore directly milled and 53,458 tons of ore sent to concentrating plants was obtained 8,804 tons of concentrates, yielding $387,426 in gold and 8,441 ounces of silver, valued at $9,454, an average in gold and silver of $45.08 a ton. The recovery of copper from the ore concentrated was 1,298,229 pounds. There was 7,407 tons of smelting ore sold or treated, yielding $10,971 in gold and 16,327 fine ounces of silver, valued at $18,286, or $3.95 a ton in gold and silver, and 749,575 pounds of copper. The total value of the smelting ore was $168,678, or $22.77 a ton.

The Jim Lee quartz mine at Altaville produced a small quantity of gold and then was closed. The Angels Camp Deep Mining Co. (Pioneer and Morse tract), at Angels, did considerable development work and completed a new 20-stamp amalgamation and concentration mill, with sawmill and other surface equipment. The Utica Mining Co., the largest enterprise at Angels, obtained all its ore in 1919 from the Gold Cliff mine. The amalgamating and concentrating mill of the mine has 40 stamps. A few small gold mines are worked in and around Angels, but none of them made any considerable output. The Penn Mining Co., at Campo Seco, did not produce as much copper as usual, owing to adverse conditions, but 5,395 feet of development work was done during the year. The copper ore from this property is treated in the 150-ton smelter, and after being converted the copper is shipped to the American Metals Co. The smelter was operated only the first 88 days of the year, but the mine was worked 360 days. The Calaveras Copper Co., at Copperopolis, owning the Empire, Keystone, and Union mines, was compelled to curtail its operations greatly during 1919. The property was operated 361 days, but on a small scale from February until August. The 200-ton furnace was not put into blast until late in August and then worked only with one shift. The oil flotation mill has a capacity of 450 to 500 tons in 24 hours. The crude ore is treated by oil flotation, the concentrates go to the smelter plant and blast furnace, and the matte is shipped to the smelter at Tacoma, Wash. During the year additions were made to the smelter, including matte crushing plant, bins, and equipment. Some gold

was obtained from the Chapman mine, at Esmeralda, by crushing the ore in an arrastre operated by a water wheel. The Royal Calaveras mine, at Felix, has a 120-stamp mill, with concentrators of a capacity of 750 tons of ore daily. The property was worked under lease from April to the middle of December. A small output was made from a few other mines at Felix, including the West Lode, or Wilbur-Womble mine.

The most productive mine in Calaveras County is the Carson Hill gold mines (Morgan and Calaveras), at Melones, only recently reopened. The ore is crushed in the 20-stamp mill, amalgamated, ground in the ball mill, and concentrated. The concentrates and sands are treated by Simmonds & Latham, who have a 20-ton concentration plant and a 500-ton cyanide tailing plant. The Morgan mine of the Carson Hill gold mines was operated throughout the year, and the Calaveras mine from June to December. In treating 77,873 tons of ore in 1919 the company recovered $1,012,600, or $13 a ton. The profit from the operations of the year, less cost of development, mining, milling, and general expenses, was $601,668, from which are deducted interest, discount, commission on notes, depletion of mineral deposits, depreciation of plant and equipment, Federal income tax, a total of $298,798, leaving a net profit for the year of $302,875. The average recovery from the ores was 90.78 per cent. The Melones Mining Co., at Melones, shut down its mine in October, 1918, owing to war conditions, but some ore was milled in cleaning out the old stopes until the milling plant was closed in February, 1919. This plant consists of a 100-stamp amalgamation and concentration mill and a tailings cyanidation plant. There is a separate concentrate cyanidation plant. While the mine was closed during 1919 the hydroelectric plant was rebuilt and the output was sold for commercial use. Some copper ore was shipped by Barron & Lowery, of Milton. The Napoleon mine, near the same place, has a 50-ton flotation mill and shipped a considerable quantity of concentrates to the smelter at Tacoma, Wash. The property was operated intermittently during a few months of the year, and part of the time tests were made with the flotation process. At the Black Wonder mine of the Calaveras Mining & Milling Co., at Mitchell Mill, hoist, boiler, and pump were installed, cabins were built, and work was begun on the concentrating mill in 1919, but the mill was not completed during the year. Additions to the plant consisted of two water wheels, rock breaker, Gibson mill, air compressor, and tracks. Only one carload of ore was shipped, but the property is in shape for large shipments in 1920. At Mokelumne Hill, North Branch, Railroad Flat, Sheep Ranch, and West Point only a few small mines were operated in 1919. The Golden Gate Exploration Co., at San Andreas, has a 20-stamp amalgamation mill and made some output in 1919, but the mill was operated for only four months.

The American Gold Dredging Co. worked its dredge productively at Camanche and the Ivy L. Borden Co. its dredge at Jenny Lind. Other producing placers were the Wicker, at Camanche; the Safe Deposit hydraulic mine, at Mokelumne Hill; the Vandalia, at Mountain Ranch; and the Johnson and Eighty-Three, at San Andreas. Of a total placer gold output of $240,385, dredging operations produced $232,258.

DEL NORTE AND HUMBOLDT COUNTIES.

No deep mines reported production from Del Norte County in 1919, and there were only a few productive placers, all of them at or near Crescent City—the Howe & Hamilton, Myrtle Creek, and Musick. The Musick is an ocean beach-sand operation. A few scattering beach-sand miners were working also in a desultory manner.

In Humboldt County all the placers reporting production were worked on the hydraulic system, and most of them were small operations at Eureka, Orleans, and Willow Creek, including the Golden Eagle, Orcutt, Salstrom, and 3-H mines.

ELDORADO COUNTY.

Eldorado is one of the five Mother Lode counties of California, but there are no very important deep mines in operation there and not many placers. Most of the former large deep mines have been idle for some time, and there is very little new development to record.

The output of the county in gold in 1919 was $30,121, as compared with $28,352 in 1918, and that of silver was valued at $279, as compared with $722 in 1918. Ten deep mines, no one large, produced 707 tons of ore, valued at $11,561 in gold and $148 in silver, a total of $11,709.

The placer mines of the county yielded $18,560 in gold and $131 in silver in 1919, as compared with $7,245 in gold and $38 in silver in 1918. In all, 30 mines (10 deep and 20 placer) in the county reported production in 1919, as compared with 23 in 1918.

The few operating deep mines at Georgetown were small ones, several being "pocket" mines. At Grizzly Flat the Morey mine and 5-stamp mill were worked only during the fall and winter when water could be procured. Very little work was done at Lotus or Latrobe. At Placerville scarcely any deep-mine gold was obtained.

Of the placers the McDermott, at Clarksville, and the Sailor Slide, at Georgetown, are sluicing mines, and there are a few sluicing mines at Lotus and Omo Ranch. Near Placerville are the Landecker, Ohio, Sylvester, Starbuck, and a few others, and at Smith Flat are the Benefeldt, Hook & Ladder, and Stone.

INYO COUNTY.

In 1919 there were 37 producing deep mines in Inyo County, which is 24 less than in 1918. Of these mines 14 were gold, 3 copper, 19 lead, and 1 zinc. The total value of the metallic output for the year was $489,618, or $1,250,685 less than in 1918. The value of the gold was $69,560, or $30,680 less than in 1918. The silver amounted to 173,349 ounces, valued at $194,151, a decrease of 268,199 ounces in quantity and of $247,397 in value. Inyo County ranked second in the production of silver in 1919. The output of copper in 1919 was 157,770 pounds, valued at $29,345, a decrease in quantity of 287,579 pounds and in value of $80,656. The output of lead in the county was 3,400,901 pounds, valued at $180,248, as compared with 12,110,453 pounds, valued at $859,842 in 1918, a decrease in quantity of 8,709,552 pounds and in value of $679,594. The production of zinc in 1919 was 223,483 pounds, valued at $16,314, a decrease of 2,289,394 pounds, as compared with 1918.

There was sold or treated in 1919 in Inyo County 20,678 tons of ore, of which 6,581 tons was siliceous ore, 102 tons copper ore, 13,311 tons lead ore, and 684 tons zinc ore. Of the gold, 1,622.94 fine ounces, valued at $33,549, was obtained from siliceous ore; 1,733.95 fine ounces, valued at $35,844, from lead ore; $55 from copper ore, and $112 from zinc ore. The production of silver from siliceous ore was 2,987 fine ounces, from copper ore 2,548 ounces, from lead ore 157,779 ounces, and from zinc ore 10,035 ounces. The siliceous ore yielded $36,894 in gold and silver, the copper ore $2,909, the lead ore $212,557, and the zinc ore $11,351, a total of $263,711 in gold and silver.

Of deep mines at Big Pine are the Base Metals, Black Group (Holliday, Grover Cleveland, Black Ann, and Black Joe), Montezuma, Empire, Birchville Mining Co. (Cometti mine), and Dunlop. The Dunlop has a 5-stamp mill, with Senn amalgamator and concentrator, replacing the old rotary mill. The Consolidated Wilshire Mining Co., 16 miles from Bishop, has a 100-ton concentrating mill and put in a ball mill in 1919, including a flotation plant. The Argus-Sterling Mining Co., at Darwin, did little in 1919. The old Darwin Lead & Silver Mining & Development Corporation has been renamed the Darwin Silver Co. and owns the Columbia, Defiance, Lucky Jim, Independence, and Promontory mines. The Lucky Jim was the only one of these operated in 1919, and some hand-picked ore from this mine was shipped to the smelter at Midvale, Utah. The Custer, Inyo Lead Syndicate, Minietta, Fernando group, Rip Van Winkle, Wonder, and a few others were all small producers at or near Darwin. The Cerro Gordo Mines Co., at Keeler, operated in a small way only from January to June, 1919, on ore carrying lead, silver, zinc, copper, and gold. The Ella group, at Darwin, was worked from February 7 to July 11 and shipped its ore to smelters at Salt Lake. The Pennsylvania, the Santa Rosa Lead & Silver Co. (old Independence mine), the Silver Reef (formerly Ventura Mining Co.), and the Lookout No. 1 shipped to smelters in Utah. The White Star, at Olancha, and the Oversight (Paddy Pride Silver Mining Co.), Ore Gulch, and Speculator, at Tecopa, were only small shippers. The Tecopa Consolidated Mining Co., at Tecopa, owning the Gunsite, Noonday, and Columbia mines, has a 100-ton concentrating mill and shipped its products to the smelter at Murray, Utah. The War Eagle mine was worked under lease. The Argus Copper Co., Gem group, and Copper Queen shipped ore by way of Trona. The Copper Queen has a 50-ton ball mill, concentrating tables, and flotation plant; the products were shipped to Midvale, Utah. The Salvage group has a 25-ton amalgamation and cyanide plant but made only a nominal output. No production of placer gold was reported from the county.

KERN COUNTY.

Thirty deep mines and 4 placers reported production from Kern County in 1919. The value of the total metallic output of the county decreased from $277,615 in 1918 to $158,991 in 1919, a decrease of $118,624. The total production of gold was $150,589 in 1919, as compared with $246,127 in 1918, a decrease of $95,538. Of the gold produced in 1919, the deep mines contributed $149,724 and the placers $865. The silver output in 1919 was 7,501 fine ounces,

valued at $8,402, as compared with 7,817 fine ounces, valued at $7,817 in 1918, a decrease of 316 fine ounces in quantity but an increase of $585 in value. The deep mines contributed 7,487 fine ounces and the placers 14 fine ounces of the silver output of 1919. No copper was produced from the mines of Kern County in 1919; in 1918 the output was 95,834 pounds, valued at $23,671.

The ore treated or sold in 1919 amounted to 17,083 tons, all of which was siliceous ore. Of the total 17,008 tons was sent to gold and silver mills and 75 tons to the smelters. The yield in bullion from the ore treated at gold and silver mills was $153,649 in gold and silver, an average value of $9.03 a ton. From the 75 tons of ore sent to smelters there was obtained $4,461 in gold and silver, or an average of $59.48 a ton. The total yield of the county in gold and silver from the deep mines was $158,110, an average of $9.26 a ton. The 4 surface placer mines of the county yielded $865 in gold and 14 fine ounces of silver, having a combined value of $881.

At Bodfish the Pickwick mine, with a 2-stamp mill, the Jack Pot group of four claims, and some other mines had a small output. The Keyes Mining Co. ran its 5-stamp mill and mine to the end of October. The King Solomon group of mines, at Johannesburg, owned by the Shipsey Mining Co., was worked part of the time by lessees; and the company itself abandoned operations toward the end of the year, owing to the high cost of production. The company has a 5-stamp amalgamation and concentration mill. At the Cow Boy mine, Loraine, a small cyanide and concentration plant was installed in 1919. Some silver ore was shipped from the Karma mine, at Mohave. The Soledad Group has a 20-stamp amalgamation and concentration mill and a 75-ton cyanide plant, on which more or less "reconstruction" was done in 1919. The Way, Gwynn (with 3-stamp mill), Piute, and Jeanette mines, in the vicinity of Caliente, were operated in a small way. The Arizona mine sent its ore to be crushed in a custom mill at Randsburg. The Black Hawk group did the same thing, and did not operate its 5-stamp mill. The Butte Lode has a 10-stamp amalgamation mill. Other small producers at Randsburg were the Minnehaha, Minnesota, Paymaster, and Buckboard mines. The Yellow Aster mine, at Randsburg, formerly the most productive mining property in southern California and having a 100-stamp amalgamation mill and extensive surface and power plant, closed down January 18, 1919, and started up with four men doing a little development work about the 1st of February. The force averaged only 8 or 10 men the rest of the year, caring for the property and milling enough ore to pay expenses. The Tropico Mining Co., at Rosamond, with a 10-stamp amalgamation mill and a 30-ton cyanide plant, operated the milling plant for only part of the time; the mine itself was worked constantly with one 8-hour shift. The Blue Mountain mine, at White River, was worked under lease and bond. The only placers operated in Kern County were the Bowman and the Miller, at Cantil, the Keyesville, at Isabella, and the May, at Randsburg, all surface-sluicing mines.

MADERA COUNTY.

Madera County in 1919 produced a total of $40,672 in value of all metals, as compared with $68,045 in 1918, a decrease of $27,373. The 1,532 tons of ore treated or sold yielded $17,705 in gold, $1,700

in silver, and 114,338 pounds of copper, valued at $21,267. Four deep gold mines and 6 copper mines reported production in 1919. The grade of gold ore treated in 1919 was much higher than that in 1918.

At Chowchilla the Apex mines shipped a small quantity of copper ore. The Mountain Lily, Consolidated Four, and Kroromick mines of the Kroromick Mining Co., at Coarsegold, are equipped with a 20-stamp amalgamation and concentration mill. Some little work was done on the mines during the entire year. A few other small gold mines were worked at and near Coarsegold. At O'Neals the productive mines were the Florence, Sunset, and a few smaller ones. In the vicinity of Raymond the Buchanan copper mine was worked under lease from the U. S. Smelting, Refining & Mining Co. Small quantities of copper ore came also from the Kates, Madera County Mining Co. (Jesse Bell and Daulton mines), and Zerzi mines.

MARIPOSA COUNTY.

Mariposa, which is one of the Mother Lode counties of California, showed a decrease of $92,013 in the value of its metallic output—from $349,544 in 1918 to $257,531 in 1919. Of the 27 mines reporting production 25 were deep mines, and they produced 12,190.84 fine ounces of gold and 3,684 fine ounces of silver from 32,070 tons of ore. The placers produced 67.01 fine ounces of gold and 12 ounces of silver. The total output of gold in 1919 was 12,257.85 fine ounces, valued at $253,392, as compared with 16,335.37 fine ounces, valued at $337,682, in 1918, a decrease of 4,077.52 fine ounces in quantity and of $84,290 in value. The total output of silver in 1919 was 3,696 fine ounces, valued at $4,139, a decrease of 1,387 ounces in quantity and of $944 in value from the output of 1918, which was 5,083 fine ounces, valued at $5,083. No copper ores were mined in Mariposa County in 1919.

The deep mines of the county produced 32,070 tons of siliceous ore, all of which was milled and yielded 12,190.84 ounces of gold and 3,684 ounces of silver, having a combined value in bullion of $256,133, an average of $7.99 a ton. From this ore was derived 496 tons of concentrates, which yielded $29,562 in gold and 918 ounces of silver, a total value of $30,590. The yield of the concentrates is thus shown to have been $61.67 a ton in gold and silver.

Small gold shipments from Bagby were made by the Chenoweth, Jumper, and Lasch mines. On the Mammoth or Quail mine, at Coulterville, a 6-ton Gibson mill was installed in 1919, but it was run only for 30 days on test ore. The Mountain View is a pocket mine, near Coulterville. The Texas Hill has a 3-stamp mill, which is to be enlarged by 10 stamps, but lack of water prevented steady work. The Virginia mine, owned by the White Gulch Mining Co., has a 10-stamp amalgamation and concentration mill and was a large producer of gold ore in 1919. The 10-stamp amalgamation and concentration mill and mine of the Original Mining & Milling Co., at Clearinghouse, were operated throughout the year and made a good production. The mine and 10-stamp milling plant of the Ruth Pierce mine at Hornitos were operated the entire year on satisfactory gold ore. Several other smaller operations were carried on at that place during the year. At Mariposa small producers were the Early

Mining Co., James, Colorado, Malone, and a few others. The mines on the famous Fremont grant, owned by the Mariposa Commercial & Mining Co., were not worked by the company in 1919, and only a small quantity of gold was produced by a few lessees of various mines. The Mountain King Mining Co., at Mountain King, has a 30-stamp amalgamation and concentration mill and made a large output of gold ore. The few producing placers in the county were sluicing mines at Coulterville and Jerseydale.

MONO COUNTY.

The total value of the metal output in Mono County increased from $54,161 in 1918 to $86,159 in 1919, a gain of $31,998. There was a decrease in gold of 88.24 ounces, or $1,824; and the silver increased from 22,727 ounces, valued at $22,727, to 49,605 ounces, valued at $55,558, an increase of 26,878 ounces in quantity and of $32,831 in value. The output of copper in 1919 was 2,425 pounds, valued at $451, as compared with 466 pounds, valued at $115, in 1918, an increase of 1,959 pounds of metal and of $336 in value. The output of lead increased from 945 pounds, valued at $67, in 1918, to 13,617 pounds, valued at $722, in 1919, an increase of 12,672 pounds in quantity and of $655 in value.

The crude ore treated at gold and silver mills amounted to 1,886 tons, which yielded $19,005 in gold and 15,603 fine ounces of silver, valued at $17,475, a total of $36,480, or an average value of $19.34 a ton in gold and silver, against an average of $31.49 in 1918. No concentrates were reported. There were 841 tons of old tailings treated, which yielded $8,896 in gold and silver, or an average of $10.58 a ton, as compared with $13.67 in 1918. The total value of the 2,727 tons of ore and tailings was therefore $45,376 in gold and silver, or an average value of $16.64 a ton, as compared with $27.82 a ton in 1918.

The Blind Spring Hill Mining Co., at Benton, did no work on its own account in 1919, but a few lessees shipped some ore. A small quantity of copper ore came from the Homestead. The ore shipped by the lessees of the Silver Reef, at Mocalno, had its highest value in silver, but it carried also gold, copper, and lead. The Wild Rose, at Benton, also shipped silver ore. The only work done on the famous old Standard mine, at Bodie, was by lessees, who took out ore from different ledges. Small shipments of gold ore were made from the Golden Gate mine of the Hall Mining Co., at Colville. The Chemung mine of the Masonic Mines Association, at Masonic, was worked only by lessees. The Silverado mine, which has a 15-ton mill and cyanide plant, shipped silver only, and that was obtained from the dumps, no ore being mined in 1919. The small Log Cabin mine, at Mono Lake, was run only on lots of ore being tested.

NEVADA COUNTY.

Nevada County was second in rank among the gold-producing counties of California in 1919, Yuba being first and Amador a close third. The total output of metals from Nevada County in 1919 was valued at $3,052,108, of which $2,981,312 was in gold, $68,731 in silver, $591 in copper, and $1,474 in lead. This was a decrease of $89,141 in gold, $3,826 in silver, $2,014 in copper, and $842 in lead from the

production of 1918, which was $3,070,453 in gold, $72,557 in silver, $2,605 in copper, and $2,316 in lead.

The output of gold from deep mines in 1919 decreased $93,587, but that from placer mines increased $4,446. The output of silver from deep mines in 1919 decreased 11,321 ounces; that from placers increased 131 ounces.

The quantity of ore and tailings treated in Nevada County in 1919 was 316,044 tons, having an average value of $9.56, as compared with 352,329 tons in 1918, having an average value of $8.85. This ore was produced by 18 deep mines. Eleven placers also were operated during the year—3 hydraulic properties that produced $17,833 in gold; 5 drift mines, $4,311; and 3 surface mines, $5,385, a total of $27,529.

Gold and silver mills in Nevada County treated 316,027 tons of siliceous ore in 1919, recovering $2,446,388 in gold and 56,264 fine ounces of silver, valued at $63,015 as bullion and producing 5,253 tons of concentrates. From these concentrates $499,106 in gold and 3,807 fine ounces of silver, valued at $4,264, 3,180 pounds of copper, valued at $591, and 27,816 pounds of lead, valued at $1,474, were obtained. The 5,253 tons of concentrates averaged $95.01 in gold and $0.81 in silver a ton.

In 1919 17 tons of slags and tailings were treated, which yielded $8,289 in gold and 1,082 ounces of silver, valued at $1,212, a total of $9,501, or an average of $558.82 a ton.

Grass Valley is the principal center of mining operations in Nevada County and the most productive deep-mining camp of the State. Even there, however, numbers of mines remained idle during 1919, owing to unfavorable mining conditions, and this state of affairs prevailed also at other points in the county. The Empire Mines, at Grass Valley, worked both the Empire and the Pennsylvania mines, which are connected underground. The company has a 20-stamp mill on the Pennsylvania and a 60-stamp mill on the Empire. During the year 20 stamps were added to the Empire mill and the cyanide plant was increased in capacity from 350 to 450 tons. Ore from the Pennsylvania is delivered to the Empire mill by electric railway. This property is the most productive deep gold mine in the State. The Golden Center, at Grass Valley, has a 20-stamp amalgamation and concentration mill. The mine was closed at the end of August, 1919, because of high prices of labor and materials. The North Star Mines Co., one of the large gold producers of the State, is equipped with a 60-stamp amalgamation and concentration mill and a 300-ton cyanide plant. The gross production of the North Star mine left an operating profit of $116,814, though the general conditions of operation remained very unfavorable throughout the year. A labor strike caused stoppage of work for several weeks, and the supply of labor was barely adequate during the remainder of the year. There was 133,100 tons of ore mined, and, after discarding 30,300 tons as waste, 102,800 tons was crushed, with an average yield of $8.95 a ton crushed, at an average cost of $7.20 a ton for operation and $0.61 for development expenses, making an average cost of $7.81 a ton crushed ($6.03 a ton mined) and leaving a realized operating profit of $1.14 a ton crushed. The yield per ton of ore crushed in 1919 was $1.16 more than in 1918. The cost of operation per ton was the same as in 1918, but the cost of development was 61 cents, as compared with 9 cents in 1918, when develop-

ment work was practically suspended. The work in various parts of the mine confirmed the expectation of finding extensions of previously developed ore bodies. The Grass Valley Consolidated Gold Mines, at Grass Valley, did about 2,500 feet of development work during the year and made a considerable output. The Champion Mines, at Nevada City, owned by the North Star Mines Co., has a 40-stamp amalgamation and concentration mill, with cyanide plant, and was worked the entire year. The production from 44,900 tons of ore crushed was $261,564, or $5.83 a ton, which was $13,958 less than expenses of operation and development. The ore all came from the Providence mine. Since the North Star Mines Co. bought the Champion mines in 1911 a total of 273,710 tons of quartz has been milled, yielding $1,506,673, or $5.51 a ton, at an aggregate cost for operation and development of $2,115,979, or $7.73 a ton. Since the end of the year all work on the Champion group has been permanently discontinued. Very few of the smaller mines at Nevada City were worked in 1919. At the Gaston, in the Washington district, the mine and 10-stamp mill were started in May and June and closed down in September, owing to high cost of material and scarcity of labor.

Eleven placer mines in Nevada County reported production in 1919. The principal ones are that of the California Placer Mines Co., at You Bet, and the Liberty Hill, at Dutch Flat, both hydraulic mines. Other placers operated were the Blue Gravel, at Dutch Flat; the Esperance, at French Corral; the Quaker Hill and Hei Kee, at Nevada City; the Bartholomew, at Relief; and the Omega, at Washington.

PLACER COUNTY.

The total value of metals produced in Placer County in 1919 was $174,805, distributed as follows: Gold, $170,609; silver, $3,141; copper, $1,055. The total value in 1918 was $459,698, which shows a decrease in 1919 of $284,893. Of the 45 mines reporting output in 1919, there were 10 deep mines and 35 placers. The total production of gold from deep mines in 1919 was 4,325.06 fine ounces, valued at $89,407, and from placer mines was 3,928.15 fine ounces, valued at $81,202, a total of 8,253.21 fine ounces, valued at $170,609. This was a decrease of 2,882.22 fine ounces of gold and of $59,581 in value, from the gold output in 1918, which was 11,135.43 fine ounces, valued at $230,190. Deep mines in 1919 produced 2,217 fine ounces of silver, valued at $2,483, and placer mines yielded 588 fine ounces of silver, valued at $658, a total of 2,805 fine ounces, valued at $3,141, a decrease of 19,627 fine ounces from the output in 1918, most of which was a reduced output by deep mines.

There was 11,373 tons of ore mined in Placer County, 11,344 tons of which was siliceous ore and 29 tons copper ore. From the siliceous ore, all of which went to gold and silver mills, 4,314.08 ounces of gold, valued at $89,180, and 2,180 ounces of silver, valued at $2,442, were recovered. Of the gold and silver recovered, $82,359 in gold and 1,474 ounces of silver were saved as bullion, and $6,821 in gold and 706 ounces of silver were recovered from the 100 tons of concentrates produced. The siliceous ore sent to mills therefore averaged $8.08 a ton in gold and silver. The average recovery as bullion was $7.40 a ton in gold and silver and the concentrates carried $76.12 a

ton in gold and silver. The copper ore, 29 tons, was shipped to a smelter and yielded $227 in gold, 37 ounces of silver, valued at $41, and 5,673 pounds of copper, valued at $1,055, a total of $1,323, or an average value of $45.62 a ton.

The placers of Placer County produced 3,928.15 ounces of gold, valued at $81,202; and 588 ounces of silver, valued at $658. Of the gold won by placers, $48,000 was from dredges, $31,094 from 28 drift mines, and $2,108 from 6 surface mines.

The Oro Fino Mining Co., Auburn, operated its mine and 10-stamp amalgamation and concentration mill continuously throughout the year. A few other smaller mines in the same vicinity were worked intermittently. At Butcher Ranch, Colfax, and Forest Hill a little pocket mining was done. Some quartz ore was worked near the old hydraulic mining camp of Dutch Flat, but the conditions were too burdensome for hydraulicking to be carried on.

The most productive placer-mining enterprise in Placer County is that of the Pacific Dredge Co., on the North Fork of American River 10 miles from Auburn. Chinese and others do more or less placer work near Auburn, Blue Canyon, Dutch Flat, Forest Hill, Iowa Hill, and Michigan Bluff. The Old Haub mine was worked in a small way at Blue Canyon. At Forest Hill the producers were the Baltimore Canyon, Dardanelles, Jarvis, Mascot, and Paragon. Those at Gold Run were the Heller, Long Ravine, and Miller. The productive mines at Iowa Hill were the Big Dipper drift and San Francisco, and those at Michigan Bluff were the Blue Eye, Glenn, Cavanaugh, and Red Star. The Pacific Slab Consolidated drift mine, at Last Chance, cleaned up in 1919, then closed down indefinitely and probably will never be reopened. The Canyon Mines Co. and Dover were worked at Towle; the American Hill at Westville; and the Cambridge at Yankee Jims.

PLUMAS COUNTY.

The value of all metals produced in Plumas County in 1919 was $2,279,385, a decrease of $766,933 from the value of the output in 1918, which was $3,046,318. The production of 1919 was distributed as follows: Gold, 4,044.15 ounces, valued at $83,600; silver, 157,005 ounces, valued at $175,846; copper, 10,859,885 pounds, valued at $2,019,939. Fourteen deep mines produced 3,245.87 ounces of gold, valued at $67,098, and 156,914 ounces of silver, valued at $175,744. From the 21 placer mines 798.28 ounces of gold, valued at $16,502, and 91 ounces of silver, valued at $102, were won in 1919. The output of copper in 1919 declined 331,858 pounds from the 1918 output of 11,191,743 pounds.

In 1919 there was treated 328,431 tons of ore, as compared with 302,893 tons in 1918, an increase of 25,538 tons. The ore treated in 1919 comprised 324,424 tons of copper ore and 4,007 tons of siliceous ore. The siliceous ore carried 1,280.78 ounces of gold and 204 ounces of silver, having a combined value of $26,704, or an average value of $6.66 a ton. The copper ore carried $40,622 in gold, 156,711 ounces of silver, and 10,859,885 pounds of copper, having a total value of $2,236,077, or an average value of $6.89 a ton. The copper content of this ore was approximately 1.67 per cent. All the siliceous ore was treated in gold and silver mills. Of the copper ore,

324,298 tons was treated by flotation concentration and yielded 20,126 tons of concentrates, from which $40,210 in gold, 155,807 ounces of silver, and 10,826,125 pounds of copper were recovered. The concentrates therefore were valued at $110.72 a ton. There was also 126 tons of copper ore sent direct to smelters, which carried $412 in gold, 904 ounces of silver, and 33,733 pounds of copper, having a total value of $61.09 a ton.

Of the deep mines of the county which reported production 8 were gold mines and 6 copper mines. Five hydraulic mines, 6 drift mines, and 10 surface placers reported operations.

Hydraulic mines produced $6,843; drift mines, $6,584; and surface placers, $3,075 of the $16,502 in gold recovered by placer mines. The production of gold by placer mines in 1919 was $11,848 less than the production in 1918.

Of the deep mines of Plumas County the Plinco Copper Mining Co. made only a small shipment of copper ore. The Engels Copper Mining Co., at Engelmine, is now the most productive copper-mining enterprise in California, and is equipped with a 1,200-ton concentration or flotation mill. The mine is developed by 4,937 feet of shafts and raises, and 27,561 feet of drifts. The development work in 1919 consisted of 5,824 feet of drifts, 1,248 feet of raises, 255 feet of shaft, and 4,644 feet of diamond drilling. The copper concentrates are shipped to the Garfield Smelting Co., Salt Lake City, Utah. Considerable silver and gold are derived from the copper ores in addition to the copper content. The Pilot gold mine, at Genesee, and the Droege, at Greenville, are small producers. The Jamison Mining Co. and the Plumas-Eureka Corporation were the only producers at Johnsville. Both were run for part time in 1919. The Walker Mining Co., at Portola, has a 200-ton flotation mill. An extensive aerial tramway has recently been completed at this property for transporting ore. The Trask & Coffer Mining Co. operated the Moonlight mine, near Engelmine. It has a 5-stamp concentration mill, and electric power and new compressors were installed during the year. Some little production was made by the Ruby and Little Joe claims, near Engelmine, in 1919. The copper ore, carrying gold and silver also, was shipped to the Garfield smelter.

There were no extensive placer-mining operations in Plumas County in 1919, but a number of drift, hydraulic, and sluicing properties produced in a small way. These were the Pioneer, at Belden; Cadmus and Great Divide, at Crescent Mills; Glacier and Sing Suey, at Greenville; Continental, Red Ravine, and Standard, at Johnsville; Blue Gravel, Plumas Grass Valley, and Smith Fork Mining Co., at La Porte; Gold Mountain and Old Rutherford, at Meadow Valley; Grizzly Creek, at Portola; Willow Creek Mining Co., at Quincy; Sunnyside and Yankee Bar, at Seneca; and Santa Cruz, at Spring Garden.

SACRAMENTO COUNTY.

Sacramento was fourth in rank among California gold-producing counties in 1919, and its total output of gold was $1,714,193, or $19,469 more than in 1918. The total yield of gold and silver was $1,719,469, or $20,108 more than in 1918. Almost the entire gold output of the county was derived from dredging operations in the vicinity of Folsom. There was only one deep mine in the county,

with a nominal output of gold and silver. Of the placers there was one drift mine, all the others being dredging mines. The Natomas Co. of California operated 9 dredges in the American River field and the Indiana Gold Dredging Co. 1 dredge near Michigan Bar. The dredge output of $1,712,705 in gold in 1919 was $22,426 more than in 1918. Considerable platinum was recovered in these dredging operations. The Natomas Co. of California handled 18,394,000 cubic yards of gravel during 1919 and used 2,520 pounds of quicksilver for amalgamation. There are two rock-crushing plants at Fair Oaks, where the cobbles, screened out, are utilized for building roads.

SAN BERNARDINO COUNTY.

The total value of the metals produced in San Bernardino County by the 27 deep mines (no placers) reporting output in 1919 was $520,075, as compared with $496,691 in 1918. This was an increase of $23,384. The ore treated amounted to 31,748 tons, which yielded 1,923.83 fine ounces of gold, valued at $39,769; silver, 381,890 ounces, valued at $427,717; copper, 252,024 pounds, valued at $46,876; and lead, 107,800 pounds, valued at $5,713.

Of the 1,923.83 ounces of gold produced, 1,836.56 ounces was obtained from siliceous ores, 76.92 ounces from copper ores, and 10.35 ounces from lead ores. The silver derived from siliceous ores was 361,974 ounces, from copper ores, 8,148 ounces, and from lead ores, 11,768 ounces. Of the total output of copper, 247,547 pounds was derived from copper ores, 3,373 pounds from lead ores, and 1,104 pounds from siliceous ores. More lead was derived from ores classed as copper (59,700 pounds) than from strictly lead ores, which carried 46,800 pounds, and 1,300 pounds was obtained by treating the ores classed as siliceous.

The ore from San Bernardino County treated in 1919 was 31,748 tons, of which 28,856 tons was siliceous ore (22,103 tons strictly silver ore), 607 tons copper ore, and 2,285 tons lead ore. The siliceous silver ore (22,103 tons) carried $21 in gold, 40,809 ounces of silver, and 148 pounds of copper, with a total value of $45,755, or an average of $2.07 a ton. The 6,753 tons of siliceous gold-silver ore carried $37,944 in gold, 321,165 ounces of silver, 956 pounds of copper, and 1,300 pounds of lead, having a total value of $397,895, or $58.92 a ton. The small quantity of copper ore treated (607 tons) carried $1,590 in gold, 8,148 ounces of silver, 247,547 pounds of copper, and 59,700 pounds of lead, with a total value of $59,924, or an average of $98.72 a ton. The lead ores (2,285 tons) carried $214 in gold, 11,768 ounces of silver, 3,373 pounds of copper, and 46,800 pounds of lead, having a combined value of $16,501, or an average of $7.22 a ton.

Gold and silver mills treated 2,784 tons of ore produced in San Bernardino County in 1919, recovering $12,341 in gold and 215 ounces of silver as bullion, a recovery of $2.54 a ton. A total of 65 tons of concentrates was produced from 2,160 tons of ore, which carried $1,493 in gold, 10,516 ounces of silver, and 15,800 pounds of lead, showing a total value of $14,108, or $217.04 a ton of concentrates. Smelters received 3,397 tons of ore in 1919, which carried $22,031 in gold, 337,449 ounces of silver, 252,024 pounds of copper, and 92,000 pounds of lead, having a combined value of $451,726, or an average value of $132.98 a ton.

The 27 mines of the county reporting operations in 1919 may be classed as follows: Gold, 11; silver, 2; copper, 10; and lead, 4. No zinc mines reported operation in 1919.

A little silver ore was shipped by Burns & De Curtain from Amboy. Some gold and silver were produced at the Bagdad-Chase property, Barstow, which has a 30-ton cyanide plant. At Cima the Piute mine made a small output. The Death Valley mine at the same place has a 10-ton concentration mill, recently installed, and shipped ore-carrying lead and silver in 1919. The Pioneer shipped its copper ore to smelters at Salt Lake City. Some output was made by the Golden Eagle, Standard, and a few other mines at Cima. The Daggett Reduction & Milling Co. worked tailings from the old silver mines at Daggett. Small quantities of ore taken out by lessees at Daggett were shipped from the Red Cloud, Waterloo, and a few other mines. The Bonanza King mine, at Goffs, has a 50-ton flotation mill and shipped silver concentrates. The California Rand Silver (Inc.), the most important purely silver mine in California, made a large production in 1919, the first year of its productive capacity. There are no reduction works at the mine, and the ore was shipped direct to the Selby smelting works, San Francisco. This mine is just over the Kern County line in San Bernardino County. The mine was discovered in May, 1919, and was worked continuously from June 24 to the end of the year. It is still in a productive state in 1920. The Gold Mountain mine, Victorville, has a 40-stamp amalgamation mill and made considerable production in 1919. At Vidal the American Eagle Consolidated mine and a few others did a small amount of work.

SHASTA COUNTY.

The total value of the metals produced in Shasta County in 1919 was $1,968,345, divided as follows: Gold, 18,299.45 fine ounces, valued at $378,283; silver, 148,038 fine ounces, valued at $165,802; copper, 7,625,658 pounds, valued at $1,418,372; and zinc, 80,658 pounds, valued at $5,888. The output of metals in 1918 was valued at $7,462,642, and the unprecedented decrease in output of $5,494,297 in 1919 is to be explained almost entirely by the closing of the Mammoth mine and smelter. In 1919 there were 23 mines in the county, 8 of which were placers and 15 deep, as compared with 13 placers and 25 deep mines in 1918. Five dredges and 3 surface mines operated in 1919, and among the deep mines 10 were gold and 5 were copper.

The deep mines of Shasta County in 1919 produced 4,243.80 fine ounces of gold, valued at $87,727, and the placer mines 14,055.65 fine ounces, valued at $290,556, as compared with 14,508.24 fine ounces of gold, valued at $299,912, from deep mines, and 11,784 fine ounces, valued at $243,597, from placer mines in 1918. Of the gold produced by deep mines in 1919, 1,271.92 fine ounces was recovered from dry or siliceous ores and 2,971.88 fine ounces from copper ores.

The mines of Shasta County produced 148,038 ounces of silver in 1919, the deep mines producing 146,536 ounces and the placers 1,502 ounces, as compared with 418,621 ounces from deep mines and 1,789 ounces from placers in 1918. Only 956 ounces of silver was recovered from dry or siliceous ores in 1919; the bulk of the silver output, 145,580 ounces, came from the copper ores.

All the copper, 7,625,658 pounds, and 80,658 pounds of zinc were recovered from 97,542 tons of copper ore, which averaged about 3.8 per cent of copper.

The ore from Shasta County mines treated in 1919 amounted to 106,052 tons, of which 8,510 tons was dry or siliceous ore and 97,542 tons was copper ore. Gold and silver mills treated 8,506 tons of dry ore, from which was recovered $25,425 in gold and 244 ounces of silver. From 11,027 tons of copper ore and 891 tons of siliceous ore, 2,178 tons of concentrates was obtained, carrying $4,775 in gold, 26,788 ounces of silver, and 623,097 pounds of copper, having a combined value of $150,673. In 1919 there was 86,519 tons of Shasta County ore sent direct to smelters, which carried $57,527 in gold, 119,504 ounces of silver, 7,002,561 pounds of copper, and 80,658 pounds of zinc, having a combined value of $1,499,735, or an average of $17.33 a ton.

The five dredges of Shasta County produced $290,008 in gold and the three surface mines $548 in gold in 1919, as compared with $238,802 by dredges and $4,795 by surface mines in 1918.

The Ruby Pearl mine, at Castella, made only a nominal gold output. The Balaklala Consolidated Copper Co., at Coram, did not make as large an output as usual, as operations were suspended on May 15, 1919. The ore was treated at the Mammoth smelter, at Kennett. The 2-stamp mill of the El Dorado and Eureka group, at French Gulch, crushed a small quantity of ore, and the Summit Gulch Mines, French Gulch, ran its 10-stamp mill part of the time only. A little gold was obtained by the Western Exploitation Co. (Milkmaid group), at French Gulch. The Afterthought Copper Co., Ingot, was operated from August 14 to December 31, 1919, mostly in experimental work on the ores. The reduction equipment consists of a 400-ton flotation mill and a 250-ton reverberatory furnace. The products were shipped to the Tacoma smelter. A small quantity of silver ore was shipped from the White Star mine, at Igo. The Mammoth plant of the United States Smelting, Refining, & Mining Co., at Kennett, where there is a smelter capacity of 1,200 tons a day, shipped its blister copper bullion to Chrome, N. J. The ore of the company came from the Mammoth mine, at Kennett, and the Shasta King mine, at Coram. For many years the Mammoth was the most productive mining property in California, but labor troubles caused the complete closing of the mine and smelter on May 15, 1919. Some development work has been done on the mine since, but no metals have been produced. The closing of this smelter had the effect of closing a number of mining properties not only in Shasta County but in Siskiyou and Trinity counties, as there was no other convenient place to ship their ore. The Mammoth made a small output of copper, silver, and gold in 1919 for reasons stated. The Midas mine of the Victor Power & Mining Co., at Knob, has four Gibson mills, with plates and concentrators of a capacity of 60 tons daily. Very little more than development work was done in 1919. The Yankee John mine, near Redding, was operated 12 months and the mill 11 months. The changes in 1919 were the installation of new hoist and mill engine; and water storage was increased by the construction of new tanks. The mine has a 12-stamp amalgamation and concentration mill. The Mountain Copper Co. closed the mines at Keswick and the smelter at Martinez early in April, 1919, and did not resume operations during the year.

Aside from a few small sluicing mines at Gas Point and Lamoine, the only placers in this county worked in 1919 were the gold dredge of the Shasta Dredging Co., at Gas Point; that of the American Gold Dredging Co., near Redding; and the Gardella dredges, at Clear Creek.

SIERRA COUNTY.

The 17 placer mines and 13 deep mines of Sierra County, which operated in 1919, produced gold and silver to the value of $304,129, of which $301,172 was gold and 2,640 ounces was silver, valued at $2,957. The output in 1918 was $289,368 in gold and 2,121 ounces of silver, valued at $2,121. Of the gold the deep mines in 1919 produced $258,561 and the placer mines $42,611. Of the silver the deep mines produced 2,351 ounces and the placers 289 fine ounces.

All the ore treated in Sierra County in 1919, a total of 30,924 tons, was siliceous and was handled exclusively by gold and silver mills, the metals being recovered as bullion; no concentrates were produced.

At Alleghany the Irelan has a 10-stamp mill and is owned by the Dunston Gold Mining Co. The Eastern Cross is a small producer. The Kanaka was operated for only 90 days and was then closed down, as were a number of other mines in and around Alleghany on account of high cost of powder and other supplies. Among these were the Mariposa Mine Association and the Morning Glory. The Original Sixteen to One Mine (Inc.), was worked continuously throughout the year, as was the 10-stamp mill. This mine is the largest producer at Alleghany. The formerly productive Tightner mine and the 20-stamp amalgamation and concentration mill were idle most of the year, and the small production made came from "clean-up" material. At the Four Hills mine, Johnsville, there is a 20-stamp amalgamating mill, and the high-grade, hand-picked tellurides and sulphurets were roasted and milled. Both the Monarch and the Cleveland mines, at Sierra City, owned in Pittsburgh, Pa., were worked the entire year. There is a 20-stamp amalgamation mill at each mine, 10 of the stamps at the Cleveland mill having been added in 1919. An electric power line was built from the power house to the Cleveland mine. Only a small quantity of gold was produced by the Primrose Mining Co., at Sierra City. Most of the mines at that place were idle during 1919.

The Yuba Development Co. operated its hydraulic mine at Brandy City only a short period in 1919. The Depot Hill hydraulic mine, at Camptonville, was worked by the Joubert Co. At Downieville the Boulder, Mugginsville, Poorman, and Wide Awake drift placers reported production. The Mugwump drift mine was the only placer reporting product at Forest, and the Kirkpatrick was the only one at Goodyears Bar. At the Mount Alta, at Pike, a lot of old tailings were worked. The Scales Gold Mining Co. operated its gravel mine at Scales by hydraulicking and automatic "shooters." The Miners Home is a drift mine at Table Rock (a town covered by gravel mining claims) and is owned by the Table Rock Mining Co. At this mine the fine gravel and clay is washed in a small water-tight bin by water under pressure. The material is then carried out over riffles. The St. Louis hydraulic mine, of the Loftus Blue Lead Mining Co., at St. Louis, was the most productive placer mine in the county, although it was worked only during April and May.

SISKIYOU COUNTY.

There were 63 mines operated in Siskiyou County in 1919, which made a total output valued at $360,652 and distributed as follows: Gold, 10,958.15 ounces, valued at $226,525; silver, 15,223 fine ounces, valued at $17,049; and copper, 629,450 pounds, valued at $117,078. As compared with 1918, this was a decrease of $89,714 in the value of the total output.

Of the gold output in 1919, the deep mines produced 1,183.01 fine ounces, valued at $24,455, and the placers, 9,775.14 ounces, valued at $202,070. The gold from deep mines was largely from siliceous ores, which yielded 989.03 ounces, valued at $20,445; the copper ores yielded 193.98 ounces, valued at $4,010. The output of placer gold in 1919 was won as follows: $49,643 by 35 hydraulic mines, $148,920 by 2 dredges, $1,137 by 1 drift mine, and $2,370 by 6 surface mines.

The silver output of the county in 1919 was distributed as follows: Deep mines, 13,543 ounces, valued at $15,168; placer mines, 1,680 ounces, valued at $1,881. The dry ores treated yielded 223 ounces of silver, valued at $250, and the copper ores yielded 13,320 ounces, valued at $14,918.

The copper output of 629,450 pounds, valued at $117,078, was all obtained from copper ores.

The ore treated amounted to 3,587 tons, of which 1,326 tons was classed as dry or siliceous ore and 2,261 tons as copper ore. The siliceous ore carried nothing but gold and silver; it was all treated in gold and silver mills and yielded all its recoverable content as bullion, which carried 989.03 ounces of gold and 223 ounces of silver, having a combined value of $20,695. All the copper ore, 2,261 tons, was sent direct to the smelter and produced 193.98 ounces of gold, 13,320 ounces of silver, and 629,450 pounds of copper, having a combined value of $136,006, or an average of $60.15 a ton.

A few quartz mines in the vicinity of Black Bear, in Siskiyou County, were worked, but the Black Bear mine itself continued idle. Very little was done at and around Callahan. The Cub Bear, at Etna Mills, was operated 10 months and the two-stamp mill two months only. The Homestead group on Salmon River, which has a two-stamp mill, was operated only from April to October. Considerable specimen ore is found in this mine and is sold as such. The Mexican Smelting & Refining Co. owns the Blue Ledge mine at Copper, and shipped its copper ore to the Tacoma Smelting Co. from Jacksonville, Oreg. In addition to the copper, this ore carries considerable silver and gold. The Dewey Gold Mines Co., at Gazelle, and the Lone Pine and Leroy Fraction, at Hornbrook, did little or nothing in 1919. The Ida May and Frances Bell mines, at Rollin, have a two-stamp amalgamation mill; and the Snow Flake and Little Gem mines, at the same place, with a small output, are being prospected. The Oregonian group (Snow Bird), at Sawyers Bar, the Easter (or Oregon), at Hoboken, and the Mount Vernon, in the vicinity of Yreka, were operated in a small way. Of these, the Easter crushed its ore in an arrastre operated by a water wheel.

Among the placers a few small ones were productive along Black Bear Creek, in the Liberty mining district. The Ole Bull and Farrington hydraulic mines were producers at Callahan. The productive hydraulic mines at Cecilville were the Banner Mining Co., Sum-

merville (or South Fork), and Jefferson Consolidated. The New Hope is a small placer in the Indian Creek mining district, Fort Jones. The Siskiyou Dredging Co., on McAdams Creek, near Fort Jones, handled 471,100 cubic yards of auriferous stream gravel in 1919. Very little other gold mining was done in the vicinity of Fort Jones during the year. The Nordheimer Mining Co. made a small output from its hydraulic mine at Forks of Salmon. At Gottville the Snowball group and Sulphur Springs hydraulic mines were productive. The hydraulic mines at Happy Camp were the Crompton, China Wong, Davis Consolidated, Nolan Bar, and Quartz Gulch. Those producing at Sawyers Bar were the Shumway (of the Forks of Salmon Mining Co.). Gold Bank, Gold Hill, Hickey Gulch, Old Humpback, Burns, and a few smaller ones. The Quartz Hill hydraulic and Roxbury were producers at Scotts Bar. The Portuguese Flat hydraulic was a producer at Seiad; also the Snyder group and Ten Eyck, at Somes Bar; and the Barkhouse Creek, at Walker. The El Oro Dredging Co. worked 670,622 cubic yards of stream gravel with its dredge on Greenhorn Creek, near Yreka, but has since worked out all its available ground and ceased operations entirely at that point. Very little other placer mining is now being carried on in the vicinity of Yreka.

TRINITY COUNTY.

The 32 placers and 9 deep mines of Trinity County in 1919 produced metals having a total value of $547,500, distributed as follows: Gold, 26,049.65 fine ounces, valued at $538,494; silver, 3,457 fine ounces, valued at $3,872; and copper, 27,600 pounds, valued at $5,134. In 1918 the production was 21,513.76 ounces of gold, valued at $444,729; silver, 6,912 ounces, valued at $6,912; and copper, 774,620 pounds, valued at $191,331. The total value of metals produced in 1919, which was $547,500, is therefore $95,472 less than the value in 1918, which was $642,972.

Of the gold output in 1919 deep mines produced 309.31 ounces, valued at $6,394, and placers produced 25,740.34 ounces, valued at $532,100. The output of the different classes of placers was $51,749 from 25 hydraulic mines, $479,503 from 4 dredges, and $848 from 3 surface placers. The deep gold mines produced 274.96 fine ounces of gold, valued at $5,684, and the copper mines 34.35 fine ounces, valued at $710.

Of the silver output in 1919 deep mines produced 261 ounces, valued at $292, and the placer mines 3,196 ounces, valued at $3,580. The copper mines were the largest contributors of the deep-mine silver output, supplying 202 ounces; the gold mines yielded only 59 ounces.

The ore treated from Trinity County mines in 1919 amounted to 467 tons, of which 208 tons was classed as dry or siliceous ore and 259 tons as copper ore. All the siliceous ore was treated in gold and silver mills without concentration and yielded 274.96 ounces of gold and 59 ounces of silver as bullion, having a combined value of $5,750, or $27.64 a ton. The copper ore, 259 tons, was sent direct to a smelter and produced 34.35 ounces of gold, 202 ounces of silver, and 27,600 pounds of copper, having a combined value of $6,070, or an average of $23.44 a ton.

The Bonanza King and Bonanza Queen group, at Carrville, owned by the Foster Gold Mining Co., is equipped with a 20-stamp amalga-

mation mill. During the year the power line was moved from the lower camp to the new transformer house. The property was operated all but two months of the year. The Brown Bear group, with its 10-stamp mill, near Lewiston, was not operated extensively. The Murphy and Layman mines, Hayfork, have a 4-stamp amalgamation mill. The Island Copper Co., at Island Mountain, did not operate in 1919, although a small quantity of copper ore was shipped. Only nominal yields were made by the Last Chance, at Lewiston, and the Five Pines and Surprise, at Trinity Center.

A very much smaller number of placer mines was operated in Trinity County in 1919 than usual. The water season was short, and other conditions were unfavorable. Of the 32 productive placers of the county in 1919, there were 4 dredges, 25 hydraulic mines, and 3 surface sluicing mines. The McAtee Bar was a small producer in the New River district, Burnt Ranch. The Pacific Gold Dredging Co. operated its dredge with eighty-eight 9 cubic foot buckets in stream gravel in Trinity River, near Carrville and handled 1,362,198 cubic yards of material during the year. The Pine Gulch and Steves Gulch hydraulic mines were worked at Coffee Creek, as were the Musick and Italy mines at Denny. The large hydraulic mines at Junction City are the Burger & Heimburger, Chapman & Fisher, and Red Hill. Near the same place, on Trinity River, is the dredge of the Valdor Dredging Co., where 1,154,898 cubic yards of river bed and bar gravel was handled in 1919. Considerable platinum and iridium were found with the gold. The Bablew Mines Co. has a hydraulic mine at Lewiston. Other mines at that point are the Trinity River Mining Co., Enos, and Richardson. The Trinity Dredging Co. and Estabrook Gold Dredging Co. operate dredges near this place; the Estabrook dredge has 75 buckets of 20 cubic feet capacity and handled 1,502,860 cubic yards of stream gravel in 1919. The hydraulic mines at Weaverville are the Gem, Kincaid, Mahoney, Arbuckle, Poverty Flat, and several mines worked by Chinese. The La Grange Mining Co. had for many years the most productive hydraulic mine in California and one of the most extensive in the world. Owing to lack of sufficient water and to the low grade of gravel encountered the properties have been operated at a loss for some years past. The company has therefore virtually abandoned the property, having ceased operations and closed down its plant in September, 1918. Part of the plant has been dismantled and sold. A little gold was obtained in 1919, however, by hydraulicking some old tailings.

TUOLUMNE COUNTY.

In Tuolumne County 30 deep and 2 placer mines were operated in 1919; they produced $482,097 in gold and silver—22,785.64 ounces of gold, valued at $471,021, and 9,889 ounces of silver, valued at $11,076.

The deep mines produced 22,717.38 ounces of gold, valued at $469,610, and the placer mines 68.26 ounces of gold, valued at $1,411. The silver output was 9,881 ounces, valued at $11,067, from deep mines, and 8 ounces, valued at $9, from placer mines.

In 1919 there were 129,660 tons of ore produced from mines in Tuolumne County, 49,781 tons of which were handled by gold and silver mills, which recovered as bullion $102,738 in gold and $1,659

in silver. Concentrates from this ore and from 79,879 tons treated in concentration mills alone amounted to 7,855 tons, from which was obtained $366,872 in gold and $9,408 in silver. The total ore treated averaged $3.707 a ton and the concentrates $47.903 a ton. Drift placers produced $972 in gold, and surface mines $439.

Of the deep mines of Tuolumne County, which is one of the Mother Lode counties, the Eureka, at Big Oak Flat, has a 1-stamp mill. The Mohrman, at the same place, made a small output. The Experimental Gulch mine, at Columbia, has a 3-stamp mill, with concentrators. The Fox or Hudson, Oregon & California, Overpocket, and Volunteer mines were small producers at Columbia. The Volunteer mine has a 3-stamp mill. The Crystalline, at Jamestown, has a 10-stamp amalgamation and concentration mill and was worked only a short time in 1919. The Pacific Coast Gold Mines Corporation, at Quartz, has a 300-ton ball mill for amalgamation and concentration. The concentrates were shipped for treatment to the Selby smelter. The Belmont-Shawmut Mining Co., at Shawmut, is equipped with a 70-stamp concentration mill. The ore is treated by a crushing, stamping, and gravity concentrator, followed by flotation concentration. Development work was done on the mine for 12 months, but productive operations for only 9 months in 1919. Many improvements have been made on this property, which was formerly known as the Eagle-Shawmut mine, and the mill has been entirely remodeled to meet the requirements of the new system of reducing the ores. The Jumper mine of the Jumper-California Gold Mines Co., at Stent, was entirely closed down in 1919, but some gold was obtained in cleaning up around the old 20-stamp mill. Considerable pocket mining was done in the vicinity of Stent, Sonora, and Tuttletown, but not nearly as much as formerly. Little or nothing was done at the Black Oak property, Soulsbyville, or at the New Providence and Grizzly mines, at Tuolumne. The Norwegian is a pocket mine at Tuttletown, which yields very high grade ore intermittently.

A little placer mining was done in the county in 1919, but not much gold was recovered.

YUBA COUNTY.

In 1919 Yuba was the leading county of California in the production of gold, exceeding Nevada and Amador counties. Thus it appears that a placer-mining county of the State is producing more gold than any of the quartz-mining counties. This superiority is due entirely to the extensive dredging enterprises carried on in the county.

The output of the county in 1919 was $4,195,732 in gold and 10,961 fine ounces of silver, valued at $12,276, a total of $4,208,008 in gold and silver, an increase of $426,279. There was no output of copper, lead, or zinc. The 12 dredges in 1919 produced $4,185,926 in gold, which was $435,893 more than in 1918. Twelve dredges, 4 sluicing mines, and 3 drift mines, or 19 in all, were in operation in 1919. No deep mines reported production.

The Pacific Gold Dredging Co. operated one of its dredges on stream gravel on Yuba River near Browns Valley. The Snowden Hill is a drift mine near Camptonville, and the Pepper is a sluicing mine near Dobbins. The most extensive gold-dredging enterprise in California, and indeed in the United States, is that of the Yuba Consolidated

Goldfields, on Yuba River at Hammonton. The eight large dredges of the company at that place handled 22,342,020 cubic yards of stream gravel in 1919. The Marysville Gold Dredging Co., on Yuba River at Marigold, has three dredges, one of which was operated the entire year, one was used to November 18, and one was destroyed by fire in May. Several small placer mines were worked in various parts of this county in 1919, but the aggregate gold recovered was inconsiderable.

OTHER COUNTIES.

Fresno.—There were a few small surface placers producing in Fresno County in 1919. These yielded $2,687 in gold and $27 in silver, a total of $2,714. The Nave, Gilroy, and other deep mines had a yield in gold of $2,853 and in silver of $40, a total of $2,893. The total yield of the county in 1919 was $5,607, of which $5,540 was gold and the remainder was silver.

Imperial and San Diego.—The Anaheim Milling & Mining Co., at Glamis, was the only deep mine reporting product from Imperial County, and the Eagle, at Julian, the only one reporting output from San Diego County.

Lassen and Modoc.—The Blue Bell deep mine, at Hayden Hill, was the only one reporting product from Lassen County; and the Hess gold mine, at Adin, the only one producing in Modoc County.

Merced, Stanislaus, and San Joaquin.—In Merced County the gold dredge of the Yosemite Dredging & Mining Co., at Snelling, after a nominal output, was closed down and dismantled. The La Grange Gold Dredging Co. operated near La Grange, in Stanislaus County. The American Gold Dredging Co. operated its dredge in San Joaquin County on Mokelumne River. The total gold output of these counties in 1919 was $162,471, or $63,558 less than in 1918.

Orange and Riverside.—In Orange County the deep mines producing were the Adkensen, Morrow group of Great Western Mining Co., and Smith, all at El Toro. The Riverside County mines were the Palisade, at Blythe, and a few small mines at Banning. The Palisade is a copper mine. The total output of these two counties was $1,701 in gold, $893 in silver, 6,700 pounds of copper, valued at $1,246, and 18,133 pounds of lead, valued at $961, a total of $4,801.

GOLD, SILVER, COPPER, AND LEAD IN OREGON.

(MINES REPORT.)

By Charles G. Yale.[1]

INTRODUCTION.

The total metal output in Oregon in 1919 was valued at $1,514,255, or $469,687 less than in 1918. The decrease in gold was $292,620 and in copper $193,446. Of the decrease in gold the placers of all kinds were responsible for $117,598. It thus appears that the larger part of the decrease for the year was in gold and that this falling off was shared by both the deep and the placer mines. In nearly all the returns received from producers comment is made on the extremely adverse conditions prevailing during the year and the difficulty of keeping mines in operation without incurring loss. Power and water were scarce, provisions and supplies were high, and labor was inefficient and difficult to obtain even at prevailing high rates. On the farms and orchards in some parts of Oregon men were paid $1 an hour and board during certain periods, and as a result they deserted the mines for more profitable work. As one of the managers of a large mining property wrote, "It is almost a farce to attempt to carry on gold-mining operations in Oregon when such conditions prevail."

Very few large mining enterprises are being carried on in Oregon, and no new ones of note were begun in 1919. In fact, several mines that were productive in 1918 ceased to be so in 1919. The only mines having a production of more than $100,000 in 1919 were the Cornucopia Gold Mines, Homestead Iron Dyke Mines, and Powder River Dredge Co., all in Baker County. The Baker Mines Co., Commercial Mining Co., and Queen of Bronze Mining Co., which were in this class in 1918, dropped out in 1919.

The gold from deep mines, which amounted to $597,194 in 1919, decreased by $175,022, as compared with 1918; and decrease was shown also in each of the various classes of placers—hydraulic, drift, surface, and dredge mines—the total decrease in gold from placers having been $117,598. The total quantity of ore treated in 1919 was 30,508 tons less than in 1918.

There were 23 less placers worked in the State in 1919 than in 1918, and 19 less deep mines. Of the deep mines 17 were gold, 1 silver, and 5 copper. Aside from the output of the dredges, the bulk of the yield of placer gold came from 34 active hydraulic mines, a little less than $9,000 coming from the combined drift and surface placers, while the dredge output was $296,750, as against $387,740 in 1918.

The southwestern counties of Oregon, which contain an extension of the California gold belt, are Benton, Coos, Curry, Douglas, Jackson, Josephine, and Lane. These counties (with the exception of Benton, Coos, and Lane, which reported no production) had a combined pro-

[1] For the preparation of the tables and other statistical data in this chapter the writer is indebted to Mrs. Daisy A. Otis.

duction of $72,208 in gold and 865 ounces of silver, valued at $969, a total of $73,177. The production of placer gold in this region in 1919 was $70,325, a decrease of $14,293, and the production of gold from deep mines was $1,883, a decrease of $41,870, which was due to prevailing adverse conditions. The total decrease in output of gold in these southwestern counties in 1919, as compared with 1918, was therefore $56,163.

Only one mine was operated productively in Curry County and only a few small placers in Douglas County. Of the 12 productive mines in Jackson County, 10 were placers. The falling off in total output of Josephine County was large in 1919, as compared with 1918, and the greatest part of the decrease was in copper.

Northeastern Oregon comprises the counties of Baker, Crook, Grant, Harney, Malheur, Umatilla, Wallowa, and Wheeler. In 1919 no metallic output was reported from Crook, Harney, Umatilla, Union, or Wallowa. The combined yield of gold in the four producing counties in this region in 1919 was $904,583, of which Baker County produced $837,863, or 92.6 per cent. There was a decrease in yield of gold in this region in 1919, as compared with 1918, of $236,126. The yield of placer gold in 1919 was $310,326, a decrease of $103,305. The lode mines produced $594,257 in gold in 1919, a decrease of $132,821. The greatest decrease in gold in any one county was in Baker—$171,793. Crook County produced nothing in 1919. The yield of gold in Grant County was $37,486 less than in 1918, but Malheur showed a nominal increase. Only a few hydraulic mines were worked in Wheeler County and they had a small output.

PRODUCTION.

SUMMARY.

Gold, silver, copper, and lead produced in Oregon, 1910–1919.

Year.	Number of mines producing.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	
1910	180	82,132	$679,488	35,978	13,861	.....	$700,676
1911	176	98,558	633,407	45,221	93,136	.....	669,016
1912	210	90,945	770,041	57,081	260,429	39,317	849,886
1913	173	155,901	1,627,710	179,036	43,330	87,207	1,746,402
1914	105	124,331	1,591,461	142,552	39,248	16,436	1,676,153
1915	95	155,791	1,861,796	117,947	451,172	62,957	2,003,509
1916	108	159,071	1,902,179	231,342	3,581,886	28,000	2,937,478
1917	76	142,438	1,491,798	125,656	2,474,487	.....	2,270,874
1918	120	126,681	1,270,465	107,323	2,451,016	10,601	1,983,942
1919	78	96,173	977,845	111,121	2,214,815	.....	1,514,255
Increase or decrease, 1919	−42	−30,508	−292,620	+3,798	−236,201	−10,601	−469,687

The total metal output of Oregon decreased in value $469,687 in 1919, as compared with a decrease of $286,932 in 1918. The quantity of ore treated decreased 24 per cent; the gold decreased 23 per cent in value; the silver increased about 4 per cent in quantity and 16 per cent in value; and the copper decreased 10 per cent in quantity.

The mine production of Oregon in 1919 had a total value of $1,514,255 and was derived from 78 producing mines, of which 55

were placers of various kinds (including 3 dredges) and 23 were deep mines, a decrease in total number of 42 from 1918.

The quantity of ore sold or treated was 96,173 short tons, a decrease of 30,508 tons, as compared with 1918. The ore averaged $7.46 a ton in gold and silver in 1919, as compared with $6.91 in 1918. The average value of all ore per ton in all metals was $11.74 in 1919 as compared with $11.69 in 1918. The siliceous ore, amounting to 67,953 tons, yielded $492,010 in gold and silver, an average of $7.24 a ton. The 28,220 tons of copper ore had a value of $225,529 in gold and silver, or an average of $7.99 a ton, and a total value in all metals of $637,484, or $22.59 a ton.

GOLD.

The total recoverable gold content of ores and gravels in Oregon in 1919 was 47,303.25 fine ounces, valued at $977,845, a decrease of 14,155.49 ounces in quantity and of $292,620 in value. The largest yield of gold from one county was $837,863 and came as usual from Baker County. The next county in rank of production was Grant, with $64,495, a decrease of $37,486 as compared with 1918. Other producing counties in relative rank as named were Josephine, Jackson, Malheur, Clackamas, Wheeler, Curry, and Douglas. The placer mines of the State produced $380,651 in gold in 1919, as compared with $498,249 in 1918, a decrease of $117,598. The hydraulic mines produced $75,016 in gold in 1919, or $11,189 less than in 1918; the drift mines $1,321, or $6,128 less; the surface placers and dredges combined, $304,314, or $100,281 less. There were 34 hydraulic mines in 1919, as compared with 50 in 1918; the number of drift mines decreased by 2 in 1919 and the number of surface placers by 5. Three dredges were in operation.

The total output of gold from deep mines in 1919 was 28,889.26 fine ounces, valued at $597,194, which was 8,466.69 fine ounces less in quantity and $175,022 less in value than in 1918. Of the gold derived from deep mines $5,316 was recovered by amalgamation, $376,342 by cyanidation, and $215,536 by smelting. Most of the concentrates obtained in milling operations were shipped to smelters for treatment. The siliceous ore of the State yielded $391,996 in gold, a decrease of $293,417, but the copper ore contained $205,198 in gold, an increase of $118,395.

Mine production of gold in Oregon in 1919, in fine ounces.

County.	Placers.	Deep mines.			Grand total.
		Siliceous ores.	Copper ores.	Total.	
Baker	11,974.70	18,674.54	9,882.38	28,556.92	40,531.62
Clackamas	.....	50.99	.....	50.99	50.99
Curry	37.01	.....	.....	.....	37.01
Douglas	35.22	.....	.....	.....	35.22
Grant	2,929.68	190.26	.....	190.26	3,119.94
Jackson	1,292.34	41.02	.....	41.02	1,333.36
Josephine	2,037.41	6.00	44.07	50.07	2,087.48
Malheur	62.16	.....	.....	.....	62.16
Wheeler	45.47	.....	.....	.....	45.47
	18,413.99	18,962.81	9,926.45	28,889.26	47,303.25
Increase or decrease	−5,688.80	−14,194.04	+5,727.35	−8,466.69	−14,155.49

Value of placer gold produced in Oregon in 1919.

County.	Hydraulic mines.	Drift mines.	Dredges.	Surface placers.	Total.
Baker	$7,321	$1,137	[a] $296,750	$258	$305,466
Curry	765				765
Douglas		184		544	728
Grant	258		(a)	2,377	2,635
Jackson	24,795			1,920	26,715
Josephine	40,493			1,624	42,117
Malheur	444			841	1,285
Wheeler	940				940
	75,016	1,321	296,750	7,564	380,651

[a] Results of dredging in Grant County included in figures for Baker County.

SILVER.

The recoverable silver content of ores and the silver from placer bullion in Oregon in 1919 aggregated 111,121 fine ounces, valued at $124,455, an increase of 3,798 ounces. Baker County in 1919 made the largest output of silver, 90,463 ounces. Grant County produced 19,662 ounces, valued at $22,021, as compared with 13,026 ounces, valued at $13,026, in 1918. The deep mines produced 107,451 fine ounces—18,154 ounces from copper ore and 89,297 ounces from siliceous ore. By amalgamation 201 ounces was recovered and by cyanidation 47,494 ounces. At the smelters 59,756 ounces was recovered.

Mine production of silver in Oregon, 1919, in fine ounces

County.	Placers.	Deep mines.				Grand total.
		Siliceous ore.	Copper ore.	Lead ore.	Total.	
Baker	2,797	69,815	17,851		87,666	90,463
Clackamas		115			115	115
Curry	2					2
Douglas	5					5
Grant	306	19,356			19,356	19,662
Jackson	239	10	153		163	402
Josephine	305	1	150		151	456
Malheur	12					12
Wheeler	4					4
	3,670	89,297	18,154		107,451	111,121
Increase or decrease	−432	+12,266	−8,007	−29	+4,230	+3,798

COPPER.

The mine production of copper in Oregon in 1919 was 2,214,815 pounds, valued at $411,955, as compared with 2,451,016 pounds, valued at $605,401, in 1918, a decrease of 236,201 pounds in quantity and of $193,446 in value. Most of the copper came from Baker and Josephine counties, but a small quantity came from Jackson County.

MINING INDUSTRY.

Gold and silver produced in Oregon in 1919, by methods of treatment.

County.	Ore to gold and silver mills.			Ore to concentrating mills.	Concentrates produced.		
	Quantity.	Gold.	Silver.		Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*	*Short tons.*		*Fine ounces.*
Baker	62,131	$377,968	47,502	32,868	7,339	$210,187	39,342
Clackamas	118	1,054	115	.....	.....	.....	.....
Grant	178	1,356	13	.....	.....	.....	.....
Jackson	43	848	10	.....	.....	.....	.....
Josephine	10	124	2	.....	.....	.....	.....
	62,480	381,350	47,642	32,868	7,339	210,187	39,342
Average per ton	.....	$6.10	$0.854	.....	.....	$28.64	$6.00

County.	Crude ore to smelter.			Old tailings treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.		*Fine ounces.*	*Short tons.*		*Fine ounces.*
Baker	30	$344	235	33	$1,825	587
Grant	182	2,577	19,343	.....	.....	.....
Jackson	43	.....	153	.....	.....	.....
Josephine	537	911	149	.....	.....	.....
	792	3,832	19,880	33	1,825	587
Average per ton	.....	$4.84	$28.11	.....	$55.61	$19.91

Gold and silver mills in 1919 in Oregon treated 62,480 tons of ore, which yielded $381,350 in gold and 47,642 fine ounces of silver, valued at $53,359. From 32,868 tons of ore sent to concentrating plants was obtained 7,329 tons of concentrates, which, with 10 tons of concentrates derived from ore directly milled, produced gold valued at $210,187 and 39,342 fine ounces of silver, valued at $44,063, a total of $254,250. Crude ore shipped to smelters amounted to 792 tons, which contained $3,832 in gold and 19,880 ounces of silver, valued at $22,266. There was also 33 tons of tailings treated, which yielded $1,825 in gold and 587 ounces of silver. The 28,220 tons of copper ore shipped yielded 2,214,815 pounds of copper, or an average of 78 pounds to the ton.

Ore sold or treated in Oregon in 1919, in short tons.

County.	Siliceous ore.	Copper ore.	Lead ore.	Total ore.
Baker	67,422	27,640	.....	95,062
Clackamas	118	.....	.....	118
Grant	360	.....	.....	360
Jackson	43	43	.....	86
Josephine	10	537	.....	547
	67,953	28,220	.....	96,173
Decrease	−20,770	−9,736	−2	−30,508
Value per ton in gold and silver	$7.24	$7.99	.....	$7.46

Mine production of gold, silver, copper, and lead in Oregon in 1919.

County.	Ore.	Quartz gold.		Placer gold.		Total gold.	
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Fine ounces.*	
Baker	95,062	28,556.92	$590,324	11,974.70	$247,539	40,531.62	$837,863
Clackamas	118	50.99	1,054	.....	.....	50.99	1,054
Curry	.....	.....	.....	37.01	765	37.01	765
Douglas	.....	.....	.....	35.22	728	35.22	728
Grant	360	190.26	3,933	2,929.68	60,562	3,119.94	64,495
Jackson	86	41.02	848	1,292.34	26,715	1,333.36	27,563
Josephine	547	50.07	1,035	2,037.41	42,117	2,087.48	43,152
Malheur	.....	.....	.....	62.16	1,285	62.16	1,285
Wheeler	.....	.....	.....	45.47	940	45.47	940
	96,173	28,889.26	597,194	18,413.99	380,651	47,303.25	977,845

County.	Quartz silver.		Placer silver.		Total silver.		Copper.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		*Fine ounces.*		*Pounds.*		
Baker	87,666	$98,186	2,797	$3,132	90,463	$101,318	2,095,491	$389,761	$1,328,942
Clackamas	115	129	.....	.....	115	129	.....	.....	1,183
Curry	.....	.....	2	3	2	3	.....	.....	768
Douglas	.....	.....	5	6	5	6	.....	.....	734
Grant	19,356	21,678	306	343	19,662	22,021	.....	.....	86,516
Jackson	163	183	239	267	402	450	823	153	28,166
Josephine	151	169	305	341	456	510	118,501	22,041	65,703
Malheur	.....	.....	12	13	12	13	.....	.....	1,298
Wheeler	.....	.....	4	5	4	5	.....	.....	945
	107,451	120,345	3,670	4,110	111,121	124,455	2,214,815	411,955	1,514,255

PRODUCTION BY COUNTIES.

BAKER COUNTY.

The total value of all metals mined in Baker County in 1919 was $1,328,942, as compared with $1,509,449 in 1918, a decrease of $180,507. The production of gold from deep mines in 1919 decreased $107,743, and that of copper increased 440,172 pounds. The silver from deep mines increased $10,926 in value. The total decrease in value of metals from deep mines was $116,464. The placer mines of the county produced $247,539 in gold, or $64,050 less than in 1918. The value of silver from placers in 1919 was $3,132, an increase of $7. There were 22 producing mines of all kinds in the county in 1919, as compared with 42 in 1918. The number of producing deep mines was 12 and of placers 10. The total quantity of siliceous ore mined and treated in the county in 1919 was 67,422 tons, or 17,780 tons less than in 1918. The gold from this ore was valued at $386,037, and the silver amounted to 69,815 fine ounces, valued at $78,193. The average recoverable value of the ore per ton in gold and silver was $6.88, as compared with $7.99 per ton in 1918.

The 62,131 tons of siliceous ore treated at gold and silver mills produced $377,968 in gold and 47,502 fine ounces of silver, valued at $53,202, an average per ton of $6.94 in gold and silver. From 32,868 tons of ore concentrated was derived 7,329 tons of concentrates, which, with 10 tons of concentrates derived from ore directly milled,

produced $210,187 in gold and 39,342 ounces of silver, valued at $44,063, a total value of $254,250, or an average value of $7.74 per ton of ore and of $34.64 per ton of concentrates. The total yield of the 94,999 tons of milling ore from the plates, from direct cyanidation, and from the concentrates was $588,155 in gold and $97,265 in silver, an average per ton in gold and silver of $7.22. In addition 30 tons of ore was shipped to smelters and produced $344 in gold and 235 fine ounces of silver, valued at $264, a total value of smelting ores of $608 in gold and silver, or an average value of $20.27 a ton, exclusive of the value of copper. There was 33 tons of tailings treated, with a recovery of $1,825 in gold and of $657 in silver.

Auburn district.—The Auburn district is now a part of Baker district, but is separately discussed in this chapter to give a better geographic distribution of the various mines. In the Auburn district there were half a dozen producing placer mines and one deep mine—the Broken Gun Barrel, a small producer. The total output of the district in 1919 was only $7,435 in gold and silver, of which $6,445 was placer gold. Fewer mines were worked in this district and the output was materially less in 1919 than in 1918.

Baker district.—The only productive mining property in the Baker district is worked by the Oregon Dredging Co. on Burnt River, near Bridgeport. The dredge has 38 buckets of 2½ cubic feet capacity each, and is operated by a gas engine.

Cable Cove district.—The only properties worked productively in the Cable Cove district were the Eagle and Miner mines of the Imperial Eagle Mining Co., at Sumpter. This property is equipped with a 100-ton amalgamating and concentrating mill. The mines were worked 12 months, but the mill was run only 18 days. Ranchers paid as high as $1 an hour and board for men in this vicinity, so men to work in the mines were scarce.

Connor Creek district.—The only productive mine that reported from the Connor Creek district in 1919 was the Huntington drift mine, at Home.

Cornucopia district.—Three deep mines were producers in the Cornucopia district in 1919, including the Union and Last Chance mines of the Cornucopia Mines Co., which have two 20-stamp amalgamating and concentrating mills, one with a 125-ton cyanide plant and the other with an 80-ton cyanide plant. There were no important changes in the mines in 1919. The Gold Reef Mining Co., formerly the Queen of the West, is equipped with a 10-stamp mill and a 50-ton cyanide plant. Only test runs were made on the ore in 1919. The total output of all the mines in the district in 1919 was $367,488 in gold and silver.

Iron Dyke district.—In value of all metals the Iron Dyke is the most productive district in Baker County and in Oregon. More than half of the value is in copper and the rest is in gold and silver. The principal property is that of the Homestead Iron Dyke Mines Co., at Homestead, which is equipped with a 100-ton flotation mill. The mine is opened by one 500-foot incline and one 450-foot vertical shaft, and some 700 feet of shaft sinking and drifting were accomplished in 1919. The ore is handled by crushing in a gyratory crusher, grinding in ball mills, and flotation concentration. The products are shipped to the International smelter, Utah. The Kuhn is a small copper

property in the same place, and a few other mines made small shipments from the district in 1919.

Mormon Basin district.—The principal mine in the Mormon Basin district, the Rainbow, of the Commercial Mining Co., was closed down and dismantled in 1918, but some gold came from the district in 1919, part of it from placers.

Robinette district.—The only productive placer reporting from the Robinette district was the Snyder Consolidated Mining Co. property, a drift mine at Rye Valley.

Rock Creek district.—The only productive mine of importance in the Rock Creek district is the Highland, of the National Mines Co., near Baker.

Sparta district.—A nominal quantity of gold was produced in the Sparta district by the Gem Consolidated mine, at Sparta.

Sumpter district.—The largest production from a single purely gold property in Oregon in 1919 came from the Powder River Dredging Co., at Sumpter. Only one dredge was worked by the company, and this has 65 buckets of 9 cubic feet capacity each.

Unity district.—A nominal quantity of gold came from the Whited quartz property, in the Unity district, in 1919.

Virtue district.—The Virtue Mines Development Co. made a small output in the Virtue district.

Whitney district.—Only a small hydraulic property reported production from the Whitney district in 1919.

CLACKAMAS AND CURRY COUNTIES.

The only property reporting production from Clackamas County in 1919 was the Ogle Mountain Mining Co., on Ogle Creek, near Oregon City. From Curry County the only report of production received was from the Trowbridge Mining Co., which worked a hydraulic mine at Marial.

GRANT COUNTY.

The producing deep mines in Grant County in 1919 were the Skyscraper, Ben Harrison, and Royal White, in the Greenhorn district. At the Ben Harrison, at Granite, the 100-ton flotation mill was not run in 1919, but the company installed six flotation machines, a classifier, elevators, and settling tanks. The Buffalo-Monitor mine, owned by the Buffalo Development Co., at Granite, was a producer.

The Cook mine, at Prairie City, and the Cougar, at the same place, made some output. The producing placer mines in the county were the Black Butte, at Beach Creek; the Caledonia, at Canyon City; the Big Nugget, at Granite; the Empire Dredging Co., at John Day; and a few smaller ones. Of these, the Empire dredge was by far the largest producer. The deep-mine yield of gold in this county in 1919 was $3,933, and that of the placers, $60,562. The value of the silver amounted to $22,021, and the total output of the county in gold and silver was $86,516.

JACKSON COUNTY.

The total output of Jackson County in 1919 was valued at $28,166, of which $27,563 was gold. The output came from 12 producing mines, of which 10 were placers and 2 were deep mines. Of the deep

mines the Sylvanite group of the Gold Hill Mines Association made a small output before the property changed hands in January, 1920. The Copper Girl Mining Co., at Rogue River, was also a small producer. The hydraulic mines in the Applegate district were the Pittock, Pacific Placer Co., Sterling Mining Co., and a few smaller ones. The total output of the district in 1919 was $22,944 in gold and silver. A few placers were worked at Ashland. The hydraulic mines producing in the Gold Hill district were the Centennial, Iron Gulch, and a few others. Some small placers tributary to Medford were also worked.

JOSEPHINE COUNTY.

The total output of gold, silver, and copper in Josephine County in 1919 was valued at $65,703, as compared with $270,192 in 1918, a decrease of $204,489. In 1919 the yield of gold from all mines was $43,152, a decrease of $29,922, and the value of silver was $510 (456 fine ounces), as compared with $581 (581 fine ounces), in 1918. In 1918 the yield of copper in the county was 795,697 pounds, valued at $196,537; in 1919 it was 118,501 pounds, valued at $22,041. This shows that the decrease in total value of the metal output of the county for 1919 was due mainly to the decreased yield and value of the copper. Twenty-two productive mines reported in 1919, of which 19 were placers and 3 deep mines, including 2 copper mines. The deep mines of the county produced in 1919, from 547 tons of ore, $1,035 in gold, 151 ounces of silver, and copper valued at $22,041, making a total value from deep mines of $23,245, as compared with $211,923 in 1918, a decrease of $188,678. The total output of the placer mines in 1919 was $42,117 in gold and 305 ounces of silver, valued at $341, as compared with $57,930 in gold and 339 fine ounces of silver, valued at $339, in 1918, a decrease of $15,811 in gold and silver. All the placer mines of the county were operated by the hydraulic method, with the exception of two small sluicing mines.

Althouse district.—The hydraulic mines in the Althouse district are the Kentla, Parker (or Goldsby), and Mint & Bullion.

Applegate and Chetco districts.—The Ocean Creek Consolidated Mining Co. owns the only hydraulic mine operated in the Applegate district in 1919, and the Lawton & Heustis was the only one worked in the Chetco district.

Galice district.—Very little placer mining was done in the Galice district in 1919 on account of lack of water, but the Corliss & Dean hydraulic, Anderson & Wilson, and a few others did a little work.

Grants Pass and Grave Creek districts.—The only placer property reporting production from the Grants Pass district was the Big Four, or Farrar hydraulic mine, at Merlin. The Browning (Gordon Gulch) and Columbia Mines Co., hydraulic mines, were the principal producers in the Grave Creek district.

Greenback and Illinois River districts.—In the Greenback district the Jason (or Payne) placer and Ruble hydraulic mines were producers at Wolf Creek. The Gold Leaf Group hydraulic mine was the only one reporting production from the Illinois River district.

Jump-off-Joe district.—The Swastika and a few other small hydraulic mines, near Grants Pass, were the only producers reporting from the Jump-off-Joe district in 1919.

Waldo district.—The most productive placer in the Waldo district was the hydraulic mine of the Waldo Corporation, at Waldo. The producing deep mines were the Waldo Smelting & Mining Co. and the Queen of Bronze copper mines, at Takilma, and the Drennan, at Golden. The copper mines made comparatively small outputs owing to adverse conditions.

MALHEUR AND WHEELER COUNTIES.

There were no deep mines worked in Malheur and Wheeler counties in 1919, and all the placers worked in Malheur County were small mines in the Mormon Basin district—the Cornelia, Golden Eagle, and Mormon Basin. In Wheeler County the Mule Gulch and Sand Gulch hydraulic mines were worked in the Spanish Gulch district. The yield of both mines was small.

GOLD, SILVER, COPPER, AND LEAD IN ALASKA.[1]

(MINES REPORT.)

By Alfred H. Brooks and George C. Martin.

PRODUCTION.

The following table gives an estimate of the total production of gold, silver, copper, and lead in Alaska since the beginning of mining in 1880. For the earlier years the figures, especially for the silver, are probably far from being correct, but they are based on the best information now available.

Gold, silver, copper, and lead produced in Alaska, 1880–1919.

Year.	Gold.		Silver.		Copper.		Lead.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.	Quantity (pounds).	Value.	Quantity. (short tons).	Value.
1880	967	$20,000			3,933	$826	.....	.....
1881	1,935	40,000			.....	.....	.....	.....
1882	7,256	150,000			.....	.....	.....	.....
1883	14,561	301,000	10,320	$11,146	.....	.....	.....	.....
1884	9,724	201,000			.....	.....	.....	.....
1885	14,512	300,000			.....	.....	.....	.....
1886	21,575	446,000			.....	.....	.....	.....
1887	32,653	675,000			.....	.....	.....	.....
1888	41,119	850,000	2,320	2,181	.....	.....	.....	.....
1889	43,538	900,000	8,000	7,490	.....	.....	.....	.....
1890	36,862	762,000	7,500	6,071	.....	.....	.....	.....
1891	43,538	900,000	8,000	7,920	.....	.....	.....	.....
1892	52,245	1,080,000	8,000	7,000	.....	.....	30	$2,400
1893	50,213	1,038,000	8,400	6,570	.....	.....	40	3,040
1894	62,017	1,282,000	22,261	14,257	.....	.....	35	2,310
1895	112,642	2,328,500	67,200	44,222	.....	.....	20	1,320
1896	138,401	2,861,000	145,300	99,087	.....	.....	30	1,800
1897	118,011	2,439,500	116,400	70,741	.....	.....	30	2,160
1898	121,760	2,517,000	92,400	54,575	.....	.....	30	2,240
1899	270,997	5,602,000	140,100	84,276	.....	.....	35	3,150
1900	395,030	8,166,000	73,300	45,494	.....	.....	40	3,440
1901	335,369	6,932,700	47,900	28,598	250,000	40,000	40	3,440
1902	400,709	8,283,400	92,000	48,590	360,000	41,400	30	2,460
1903	420,069	8,683,600	143,600	77,843	1,200,000	156,000	30	2,520
1904	443,115	9,160,000	198,700	114,934	2,043,586	275,676	30	2,580
1905	756,101	15,630,000	132,174	80,165	4,805,236	749,617	30	2,620
1906	1,066,030	22,036,794	203,500	136,345	5,871,811	1,133,260	30	3,420
1907	936,043	19,349,743	149,784	98,857	6,308,786	1,261,757	30	3,180
1908	933,290	19,292,818	135,672	71,906	4,585,362	605,267	40	3,360
1909	987,417	20,411,716	147,950	76,934	4,124,705	536,211	69	5,934
1910	780,131	16,126,749	157,850	85,239	4,241,689	538,695	75	6,600
1911	815,276	16,853,256	460,231	243,923	27,267,878	3,408,485	51	4,590
1912	829,436	17,145,951	515,186	316,839	29,230,491	4,823,031	45	4,050
1913	755,947	15,626,813	362,563	218,988	21,659,958	3,357,293	6	528
1914	762,596	15,764,259	394,805	218,327	21,450,628	2,852,934	28	1,344
1915	807,966	16,702,144	1,071,782	543,393	86,509,312	15,139,129	437	41,118
1916	834,068	17,241,713	1,379,171	907,495	119,854,839	29,484,291	820	113,160
1917	709,049	14,657,353	1,239,150	1,021,060	88,793,400	24,240,598	852	146,584
1918	458,641	9,480,952	847,789	847,789	69,224,951	17,098,563	564	80,088
1919	455,984	9,426,032	629,708	705,273	47,220,771	8,783,063	687	72,822
	15,076,793	311,664,993	9,019,016	6,303,528	545,007,336	114,526,096	4,184	522,258

[1] The data on mining conditions and production here given are abstracted from a paper published in U. S. Geol. Survey Bulletin 714. The authors were assisted in the statistical work by T. R. Burch. The original paper and the papers that accompany it treat the subject at greater length than is desired here and they should be consulted by those who require the more detailed information.

Gold and copper mining have always been the principal mineral industries of Alaska, and in 1919 both were subject to great depression throughout the world. Hence the value of Alaska's mineral production decreased from about $28,300,000 in 1918 to about $19,600,000 in 1919, of which gold, silver, copper, and lead amounted to $27,507,392 in 1918 and $18,987,190 in 1919.

GOLD AND SILVER.

The subjoined table gives an estimate, based on the best available data, of the gold and silver produced in Alaska from different sources since mining began in 1880. About $65,900,000 worth of gold, or about one-fifth of the total estimated output, was produced before 1905, and there is but scant information as to its source. For the period since that time fairly complete statistical returns are available, and it is probable that the figures presented in the following table are sufficiently accurate to be valuable. The figures given for the silver recovered from placer gold and from siliceous ores are probably less accurate than those for the gold. Copper mining did not begin in Alaska until 1901, and the figures for gold and silver derived from this industry, as now presented, are therefore a close approximation to the actual output.

Gold and silver produced in Alaska from different sources, 1880–1919.

Source.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
Siliceous ores[a]	4,446,528	$91,917,907	1,428,580	$1,053,130
Copper ores	83,886	1,734,094	5,815,886	4,213,418
Placers	10,546,379	218,012,992	1,774,550	1,036,980
	15,076,793	311,664,993	9,019,016	6,303,528

[a] Including small quantities of lead ore.

This table shows that about 70 per cent of the total gold produced in Alaska has been obtained from placer mines. In 1919 the placer-gold production was 52.7 per cent; in 1918, 62.2 per cent; in 1917, 66.9 per cent; in 1916, 64.6 per cent; in 1915, 62.7 per cent; in 1914, 68.1 per cent; in 1913, 68.3 per cent; and in 1912, 69.9 per cent.

Gold and silver produced in Alaska, 1919, by sources.

Source.	Ore (tons).	Gold.		Silver.	
		Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
Siliceous ores	3,262,573	212,474	$4,392,237	108,691	$121,734
Copper ores	492,644	3,086	63,795	488,034	546,598
Placers		240,424	4,970,000	32,983	36,941
	3,755,217	455,984	9,426,032	629,708	705,273

LODE MINING.

Twenty-three gold-lode mines and two prospects were operated in Alaska in 1919 and produced gold worth $4,392,237. Twenty-five mines were operated in 1918 and produced gold worth $3,473,317. The increase in 1919 came from the four large mines in the Juneau and Sitka districts. The increased production at Juneau does not assure the continued prosperity of the lode-mining industry, for these mines are working on too small a margin between the value of gold recovered and the cost of operation to make it certain that they will be able to pay the continually increasing expense of mining. The only other large gold-lode mine in Alaska is in the Sitka district, where operations in 1919 were on a somewhat larger scale than in 1918.

Of the producing mines, seven were in southeastern Alaska, one in the Copper River district, three on Kenai Peninsula, five in the Willow Creek district, six in the Fairbanks district, and one on Seward Peninsula. In 1919 the average value of the gold and silver contents for all siliceous ores mined was $1.38 a ton; the average for 1918 was $1.70 a ton. These averages reflect the dominance in the total lode production of the large tonnage produced from the low-grade ores of the Juneau district.

Gold and silver produced from gold-lode mines in Alaska, 1919, by districts.

District.	Mines operated.	Ore mined (short tons).	Gold.		Silver.		Average value per ton of ore in gold and silver.
			Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.	
Southeastern Alaska	[a] 7	3,253,848	201,937	$4,174,407	107,359	$120,242	$1.32
Kenai Peninsula	3	96	435	8,987	284	318	96.93
Willow Creek	5	6,730	7,882	162,944	508	569	24.30
Fairbanks district	6	1,384	2,027	41,893	378	424	30.58
Other districts [b]	2	515	193	4,006	162	181	8.13
	23	3,262,573	212,474	4,392,237	108,691	121,734	1.38

[a] Also shipment from one prospect.
[b] Includes 1 mine in the Copper River district and 1 in Seward Peninsula; also 1 prospect on Prince William Sound.

The prospecting and development of gold lodes in 1919 was most active in the Willow Creek district, which lies adjacent to the railroad, but in which no property has yet been opened up and equipped on a large scale. There was good reason to believe that lode mining in the Willow Creek district would make substantial gains in 1920. At Fairbanks lode mining and prospecting have almost ceased, the only operations being those of a few owners who continue a little development with the plan of blocking out ore to be mined when the railroad is completed. Incidental to this work a little ore is recovered and milled, and there are many small auriferous lodes in the Fairbanks district which can be profitably exploited when the economic conditions improve. Comparatively little work was done on the lodes of Seward Peninsula in 1919. A gold-lode mine near Bluff was operated and made a small output, and some ore was mined but not shipped from the silver-lead prospect on Kugruk River.

PLACER MINING.

During 40 years of mining Alaska has produced gold to the value of more than $311,000,000, and $218,000,000 of this amount is to be credited to her placer mines. The value of the placer-gold output of Alaska decreased from $5,900,000 in 1918 to $4,970,000 in 1919, and it was evident that the output would be less in 1920. The decrease was general for all Alaska districts except for some in Seward Peninsula and the Kuskokwim region. It was due largely to conditions that affect gold mining adversely throughout Alaska. Shortage of labor, lack of transportation, and unfavorable seasonal climatic conditions have also operated to curtail the placer-gold output of certain districts. The depletion of bonanza placers also helped to decrease placer mining. No important discoveries of placer gold were made during the year, and there was a marked decrease in prospecting for placer gold.

About 466 placer mines were operated in the summer of 1919 and 88 during the previous winter, but many for only a part of the season. About 2,177 men were engaged in productive placer mining in the summer and 318 in the winter. In addition several hundred men were engaged in prospecting or other nonproductive work relating to placer mining. No important new placer-bearing areas were discovered in 1919.

Gold and silver produced from placer mines in Alaska, 1919, by regions.

Region.	Gold.		Silver.		Gravel handled (cubic yards).	Recovery per cubic yard.	Number of mines.		Number of miners.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.			Summer.	Winter.	Summer.	Winter.
Southeastern Alaska	1,209.37	$25,000	204	$229	20,000	$1.26	9	.....	29	.....
Copper River region	8,949.38	185,000	912	1,021	340,000	.55	18	.....	115	.....
Cook Inlet and Susitna region	5,321.25	110,000	827	926	191,000	.58	21	.....	81	.....
Southwestern Alaska	241.88	5,000	22	25	3,000	1.67	5	.....	10	.....
Yukon basin	140,771.25	2,910,000	19,461	21,796	1,616,000	1.81	274	76	1,246	255
Kuskokwim region	16,931.25	350,000	4,431	4,963	205,000	1.73	20	2	101	3
Seward Peninsula	65,790.00	1,360,000	6,940	7,773	2,165,000	.63	103	10	555	60
Kobuk region	1,209.37	25,000	186	208	8,000	3.15	16	.....	40	.....
	240,423.75	4,970,000	32,983	36,941	4,548,000	1.10	466	88	2,177	318

The following table is based in part on returns made by placer-mine operators and in part on known facts or assumptions concerning the richness of the gravels in the several districts. Although the table is thus in part an estimate, it is probably nearly correct.

Gravel sluiced in Alaskan placer mines and value of gold recovered, 1908–1919.

Year.	Total quantity of gravel (cubic yards).	Value of gold recovered per cubic yard.	Year.	Total quantity of gravel (cubic yards).	Value of gold recovered per cubic yard.
1908	4,275,000	$3.74	1914	8,500,000	$1.26
1909	4,418,000	3.66	1915	8,100,000	1.29
1910	4,036,000	2.97	1916	7,100,000	1.57
1911	5,790,000	2.17	1917	7,000,000	1.40
1912	7,050,000	1.70	1918	4,931,000	1.20
1913	6,800,000	1.57	1919	4,548,000	1.10

The table shows that from 1908 to 1914 there was a decline in the average gold content of the gravels mined. This decline reflects the improved methods of placer mining that have been introduced, more especially the increase in the use of dredges, which is brought out in the following table:

Relation of recovery of placer gold per cubic yard to proportion produced by dredges, 1911–1919.

Year.	Percentage of placer gold produced by dredges.	Recovery per cubic yard.		
		Dredges.	Mines.	All placers.
1911	12	$0.60	$3.36	$2.17
1912	18	.65	2.68	1.70
1913	21	.54	3.11	1.57
1914	22	.53	2.07	1.26
1915	22	.51	2.33	1.29
1916	24	.69	2.64	1.57
1917	26	.68	2.21	1.40
1918	24	.57	1.84	1.20
1919	27	.77	1.31	1.10

Gold dredging continues to hold an important place in Alaska placer mining. In 1919 there were 28 dredges in operation for the whole or part of the season and they produced gold to the value of about $1,360,000, compared with $1,425,000 worth of gold produced by 28 dredges in 1918. Two of these dredges were operated in 1919 in the Fairbanks district, 2 in the Iditarod district, 1 in the Birch Creek district of the Yukon basin, 1 in the Mount McKinley (McGrath) district of the Kuskokwim basin, and 22 on Seward Peninsula. These dredges handled about 1,760,000 cubic yards of gravel, compared with about 2,490,000 cubic yards of gravel handled in 1918. The average recovery of gold per cubic yard was about 77 cents in 1919 and 57 cents in 1918. The gold dredges of Seward Peninsula produced gold worth $450,000 from about 865,000 cubic yards of gravel, making an average recovery of 52 cents a cubic yard in 1919 compared with 40 cents a cubic yard in 1918. The dredges of the Yukon and Kuskokwim districts produced gold worth $910,000 from 895,000 cubic yards of gravel, and the value of the gold recovered per cubic yard was therefore about $1.02. In 1918 the dredges of the Alaska Yukon districts produced gold worth $881,000 from 1,125,000 cubic yards of gravel, the value of the gold recovered per cubic yard being about 78 cents.

Though dredges were built for use in the Alaska Yukon as early as 1898, and at Nome in 1900, this method of placer mining did not reach a profitable stage until 1903, when two small dredges were successfully operated in Seward Peninsula. Dredging began in the Fortymile district in 1907; in the Iditarod, Birch Creek, and Fairbanks districts in 1912; in the Yentna district in 1916; and in the Kuskokwim region in 1918 when the new dredge on Candle Creek was completed and operated for a short period, although it did not begin regular operations till 1919. The fact that this dredge and also one of the Fairbanks dredges, which likewise was first operated in 1919, had successful seasons shows that dredging can be profitable even under present adverse conditions. This fact and the successful gold dredging in Seward Peninsula during the last 15 years proves that mining of this type has an important future in Alaska. In nearly every placer-mining district of Alaska there are large areas underlain by auriferous gravels which justify exhaustive prospecting for the purpose of finding dredging ground. The successful use of cold-water thawing in connection with dredging should give a further stimulus to this form of mining. Up to the end of 1919 gold to the value of $20,395,000 had been mined by dredges.

Gold produced by dredge mining in Alaska, 1903–1919.

Year.	Number of dredges operated.	Value of gold output.	Gravel handled (cubic yards).	Value of gold recovered per cubic yard.
1903	2	$20,000	.....	.....
1904	3	25,000	.....	.....
1905	3	40,000	.....	.....
1906	3	120,000	.....	.....
1907	4	250,000	.....	.....
1908	4	171,000	.....	.....
1909	14	425,000	.....	.....
1910	18	800,000	.....	.....
1911	27	1,500,000	2,500,000	$0.60
1912	38	2,200,000	3,400,000	.65
1913	35	2,200,000	4,100,000	.54
1914	42	2,350,000	4,450,000	.53
1915	35	2,330,000	4,600,000	.51
1916	34	2,679,000	3,900,000	.69
1917	36	2,500,000	3,700,000	.68
1918	28	1,425,000	2,490,000	.57
1919	28	1,360,000	1,760,000	.77
	.....	20,395,000	.....	.....

COPPER.

The copper output of Alaska in 1919 was 47,220,771 pounds, valued at $8,783,063. This is less than the output in 1918, which was 69,224,951 pounds, valued at $17,098,563. During the year, 11 copper mines were operated, compared with 17 in 1918. Of these mines, 3 are in the Ketchikan district, 5 in the Prince William Sound district, and 3 in the Chitina district. The curtailment of copper mining was due to the fall in the price of copper and the uncertainty of the market. Throughout the war the small operator was hampered by lack of shipping to transport his ore and of smelters to reduce it, conditions that blocked the development of a number of properties and discouraged the copper-mining industry. Largely for

these reasons there has been relatively little prospecting for copper during the last few years. Should freight rates decrease or the price of copper go up, many small mines would resume operations and the larger low-grade ore bodies would be developed. Under existing industrial conditions there was no likelihood of any improvement during 1920.

Output of Alaska copper mines in 1919, by districts.

District.	Mines operated.	Ore (tons).	Copper.		Gold.		Silver.	
			Quantity (pounds).	Value.	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.
Ketchikan district	3	8,936	629,100	$117,013	674.10	$13,935	5,261	$5,892
Chitina district [a]	[b] 3	195,631	36,291,390	6,750,198	.....	.....	408,726	457,773
Prince William Sound	5	288,077	10,300,281	1,915,852	2,411.98	49,860	74,047	82,933
	11	492,644	47,220,771	8,783,063	3,086.08	63,795	488,034	546,598

[a] Kennecott Corporation Ann. Rept. for 1919. [b] Also a small quantity of placer copper.

In southeastern Alaska the Rush & Brown mine was the largest copper producer. Copper was also produced at the Salt Chuck mine, better known for its output of palladium, and some ore was shipped from the Jumbo mine, at Sulzer. The three large mines, the Bonanza, Jumbo, and Mother Lode, of the Kennecott group, were the only producing mines of the Chitina district in 1919, though some development work was done on other properties. Some placer copper was also recovered incidentally to gold-placer mining in the Nizina district. On Prince William Sound the Beatson-Bonanza and Ellamar copper mines were the only properties worked systematically throughout the year. Some ore was, however, also produced incidentally to development work at the Fidalgo or Schlosser mine of the Alaska Mines Corporation, at the Fidalgo or Mackintosh mine of the Fidalgo Mining Co., and at the mine of the Ladysmith Smelting Corporation, on Latouche Island.

The average copper content of the ores mined in 1919 was 4.8 per cent. The ores also yielded an average of $0.129 in gold and $1.11 in silver to the ton. The average yield for 1918 was 4.8 per cent of copper, $0.149 to the ton in gold, and $0.996 to the ton in silver.

Most of the prospecting for copper in 1919 was done in the Susitna basin, tributary to the Alaska Railroad. A number of copper lodes of some promise have been found in this region, but they have not been sufficiently developed to prove their value.

LEAD.

The lead produced in Alaska in 1919 is estimated at 687 tons, valued at $72,822, compared with 564 tons, valued at $80,088, in 1918. The output of lead in 1919 was derived wholly from the concentrates of the gold mines at Juneau. Some lead-silver ore was mined in the Kantishna district, but not shipped in 1919.

During 1919 development work was done on galena ores in southeastern Alaska, in Seward Peninsula, in the Yukon basin, and probably in other regions. In the course of this work some ore was produced, but so far as known no ore was shipped.

SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.

(MINES REPORT.)

By J. P. Dunlop.

INTRODUCTION.

The following is an account of the production of silver, copper, lead, and zinc in 1919 by the mines of the Central States, including Arkansas, Illinois, Kansas, Kentucky, Michigan, Missouri, Oklahoma, and Wisconsin. The territory thus embraced lies in the great interior valley province of the United States, which extends from the Appalachian system to the Rocky Mountain front, excluding the Black Hills. Most of the mines are developed in the Paleozoic sedimentary rocks of this province, but the copper range of northern Michigan comprises lavas and intercalated sediments of pre-Cambrian age.

The statistics of production in these States have been compiled by the United States Geological Survey from confidential reports by each mine in operation and represent the quantity of metals recovered or paid for in the ore that was treated or sold during the year.

The method of marketing and recording the mine output in the lead and zinc regions of the United States differs from that employed in the Western States. In the Western States the miner usually sells his ore according to the assay content of metal at a certain price per unit. In the lead and zinc regions of the Central States, however, where the material sold is principally concentrates,[1] payment is made according to a basis price for a certain quality of concentrates. The details of this method are given in the pages devoted to Missouri in this report for 1914. The figures reported to the Geological Survey by producers represent the quantity and assay content of concentrates sold and the amount received in payment. The total metal produced is calculated from the first two of these items.

The operators in Michigan report the quantity of concentrates produced and the actual recovery of copper from concentrates smelted.

In any year the mines may produce more or less concentrates than are smelted during the same period. The copper content of concentrates produced but not smelted during the year has been estimated on the basis of the average copper recovery per ton for the year of the company producing it.

[1] In local usage the ore as mined is called "dirt" and the concentrates are classed as "ore." Where the capacity of a concentrating plant is given, such capacity is to be understood as based on a 10-hour shift unless otherwise stated.

Owing to the delay in compiling the data obtained in cooperation with the Bureau of the Census the district reviews published in previous years giving details of the operations of the mining companies have been omitted.

TENOR OF LEAD AND ZINC ORES OF THE CENTRAL STATES.

Much of the ore mined in the Western States is crude smelting ore—that is, it can be smelted directly without preliminary concentration. All but a very small portion of the ore from the Central States is of such tenor that it requires concentration. The only fair basis for comparison of the relative magnitude of mining operations in different States is that of quantity of crude ore, or "dirt," as it is usually called in the lead and zinc regions of the Central States. In the Joplin and upper Mississippi Valley regions the number of cans of ore hoisted is usually recorded and the approximate weight of the cans is generally known. Thus each company knows, in a general way, about what percentage of concentrates the run of mine is yielding. Knowing the total production of concentrates and the average yield of concentrates from crude ores, one can arrive at a close estimate of the crude ore raised. Only the operating companies have the data, however, and it was the practice of the Geological Survey, in order to shorten the list of producers as much as possible, to send requests only to the owners of the mining land or the companies holding first leases and to depend upon them to report the whole production of the tract. Since 1911 not only the first lessees of the land have reported to the Survey, but also most of the sublessees have given data regarding both concentrates produced and "dirt" or ore milled. The tables of tenor of ore which follow in the sections devoted to the respective States show the comparative percentages for the last three years.

In Kentucky and southern Illinois the lead and zinc concentrates are recovered as by-products in the concentration of the fluorspar which they accompany, and it was not possible to make calculations of the metal content of the crude ore raised.

Tenor of copper, lead, and zinc ores of Central States, 1917–1919.

State.	1917		1918		1919	
	Crude ore.	Metal content.[a]	Crude ore.	Metal content.[a]	Crude ore.	Metal content.
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*	*Short tons.*	*Per cent.*
Arkansas	203,600	3.89	37,000	3.18	5,800	4.2
Illinois (northern)	327,340	1.81	280,900	2.10	404,000	2.4
Iowa	1,000	.....	.....	.....	.....	.....
Kansas	903,400	2.82	1,025,400	3.97	1,391,600	4.6
Michigan	12,400,723	1.03	11,321,365	1.00	7,690,253	1.1
Missouri	17,024,000	2.24	9,146,800	2.80	[b] 5,690,730	3.4
Oklahoma	3,523,200	3.45	5,754,700	4.11	6,168,200	3.7
Wisconsin	3,014,800	2.57	2,377,300	2.80	1,826,200	2.9
	37,398,063	.....	29,943,465	.....	23,176,783	.....

[a] The percentages given in this column represent the metal content of the ore in so far as it is recovered in the concentrates. In Michigan the metal so recovered is copper, in the other Central States the metals are lead and zinc, the relative proportions of which are shown in the table on another page and in the tables of tenor of ore given in the sections devoted to the respective States.

[b] 57,000 tons of cobalt-nickel-copper ore excluded.

This table shows that there was a decrease of about 6,766,700 short tons in the quantity of ore from the copper, lead, and zinc mines of the Central States treated in 1919, following a decrease of 7,455,000 tons in 1918. The production of ore from the copper mines of Michigan decreased 3,631,100 tons, and the production of ore in Missouri decreased more than 3,456,000 tons, of which 1,628,800 tons was chargeable to the "sheet ground" mines. The mines of the disseminated-lead district in southeastern Missouri decreased their output about 1,230,700 tons. Other States which had a decreased output of lead and zinc ore in 1919 were Arkansas and Wisconsin. The increases in 1919 in other States were as follows: Illinois, 124,000 tons; Oklahoma, 413,500 tons; and Kansas, 366,200 tons.

The low average tenor of the crude ore mined in the Central States in 1919 is best shown by the fact that the average value of the total recoverable metal content was only $4.47 a ton of crude ore treated and that this value was $0.55 less than in 1918. The 15,486,530 tons of zinc, lead, and lead-zinc ores treated in the Central States in 1919 yielded lead and zinc concentrates which sold for $42,610,460, so that the mine operators realized an average of $2.75 a ton of ore mined and treated, against $3.14 a ton in 1918. Both the quantity and the value of lead and zinc concentrates and also the value of both metals were less in 1919 than in 1918. There were substantial increases in the mining and milling costs, so that many mines were operated without a profit.

PRODUCTION.

The total value of the mine production of silver, copper, lead, and zinc in the Central States in 1919 was $103,643,361, a decrease of $45,744,705, or about 31 per cent, compared with the value for 1918. The total value of the mine production of these metals for the years 1907 to 1919, inclusive, was $1,246,610,692, of which $511,945,295 was for copper, $441,529,050 for zinc, $288,620,862 for lead, and $4,515,485 for silver. Only in 1915, 1916, and 1919 has the value of the recoverable zinc exceeded that of the copper.

SILVER.

The production of silver in the Central States in 1919 was 536,271 fine ounces, which at the dealers' buying price of $1.12 a fine ounce (12 cents higher than in 1918) was valued at $600,624, as compared with 564,577 fine ounces, valued at $564,577, in 1918. Nearly all the silver that is produced in the Central States is recovered incidentally in the production of other metals. Of the output in 1919, 441,430 ounces came from the copper lodes of Michigan, a decrease of 68,037 ounces. About 35 per cent of the concentrates from lead ores mined in southeastern Missouri was desilverized and yielded most of the silver from that State recovered in 1919, and 29,480 ounces of silver was derived from nickel-cobalt-copper ore. The total quantity of silver from ores mined in Missouri was 90,401 ounces.

The lead-zinc-fluorspar deposits of the Kentucky-Illinois field also carry silver, and from the lead concentrates derived from Illinois 4,440 ounces of silver was recovered, a decrease of 3,731 ounces.

COPPER.

The mine production of copper in the Central States in 1919 came from Michigan and Missouri, and amounted to 180,443,686 pounds. The copper production of Michigan, which, as in other years, contributed nearly the entire output, was 178,826,486 pounds, which at the average selling price of 18.6 cents a pound was valued at $33,261,726, as against a yield of 226,794,139 pounds, valued at $56,018,152, in 1918. The copper produced in Missouri in 1919, amounting to 1,617,200 pounds, valued at $300,799, was derived mainly from ore mined by the Missouri Cobalt Co. in Madison County.

The total mine production of copper from Michigan and Missouri in 1919 was about 46,928,100 pounds less than in 1918 and 93,000,000 pounds less than in 1916.

LEAD.

The mine production of lead in the Central States in 1919 was 234,878 short tons, which, rated at the average selling price for all grades for the metal for the year of 5.3 cents a pound ($106 a ton), was valued at $24,897,068, as compared with 264,635 short tons, valued at $37,578,170, in 1918. The output of lead decreased 29,757 tons in quantity in 1919 and $12,681,102 in value. In 1919 Missouri produced 70 per cent of the yield of lead in the Central States, against 73 per cent in 1918, and the recoverable lead content of galena and lead carbonate concentrates mined in Missouri in 1919 equaled 38 per cent of the refined primary lead recovered in the United States from domestic ore. Of the total output of lead in Missouri the disseminated-lead district of southeastern Missouri produced 156,676 tons, a decrease of 24,716 tons, but this district again exceeded the Coeur d'Alene district of Idaho and retained first place in production of lead in the United States. Small lead mines and a barytes mine in southeastern Missouri reported the recovery of 482 tons of lead. Southwestern Missouri had an output of 6,132 tons, or 6,651 tons less than in 1918. The production in Oklahoma decreased from 56,097 tons in 1918 to 53,872 tons in 1919, but the output of the Miami district in 1919 was more than twice as large as the combined output of all regions other than southeastern Missouri.

The production from Kansas mines increased from 7,252 tons in 1918 to 11,283 tons in 1919; Illinois decreased from 2,273 tons to 2,105 tons; and Wisconsin from 4,533 tons to 4,214 tons. The total production of lead from mines in the southern Illinois-Kentucky region, Arkansas, and the upper Mississippi Valley region amounted to only 2.7 per cent of the output of the Central States.

ZINC.

The production of zinc in the Central States in 1919, based on mine returns, with a deduction for separating and smelting losses, was 305,364 short tons, valued at $44,583,144. The value is computed at 7.3 cents a pound ($146 a ton), the average selling price reported by the smelters for all grades of the metal.

The output in 1919 was the second largest recorded yield from mines in the Central States, being less than that of the year 1917 by

5,107 tons. Although the quantity was about the same as in 1918, the value decreased $10,501,340. The production of zinc in the Central States was about 67.5 per cent of the total production of primary zinc from domestic ores in the United States in 1919, against 61.5 per cent in 1918.

SUMMARY OF PRODUCTION, BY STATES.

Mine production of silver, copper, lead, and zinc in the Central States in 1919.

State.	Silver.		Copper.		Lead.		Zinc.		Total value.
	Quantity (fine ounces).	Value.	Quantity (pounds).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Arkansas					28	$2,968	189	$27,594	$30,562
Illinois	4,440	$4,973			2,105	223,130	6,788	991,048	1,219,151
Kansas					11,283	1,195,998	47,636	6,954,856	8,150,854
Kentucky					86	9,116	36	5,256	14,372
Michigan	441,430	494,402	178,826,486	$33,261,726					33,756,128
Missouri	90,401	101,249	1,617,200	300,799	163,290	17,308,740	31,540	4,604,840	22,315,628
Oklahoma					53,872	5,710,432	178,410	26,047,860	31,758,292
Wisconsin					4,214	446,684	40,765	5,951,690	6,398,374
Total, 1919	536,271	600,624	180,443,686	33,562,525	234,878	24,897,068	305,364	44,583,144	103,643,361
1918	564,577	564,577	227,371,804	56,160,835	264,635	37,578,170	302,662	55,084,484	149,388,066

For the second time the production of zinc in Oklahoma exceeded that of Missouri. For many years Missouri had been the largest producer of zinc in the United States, but the output decreased from 132,918 tons in 1917 to 31,540 tons in 1919, while that of Oklahoma increased from 85,835 tons in 1917 to 178,410 tons in 1919. Moreover, both Kansas and Wisconsin exceeded Missouri in 1919, Kansas, which had an output of 20,249 tons of zinc in 1917, having produced 47,636 tons in 1919 and Wisconsin 40,765 tons. Arkansas decreased in output from 951 to 189 tons, and Kentucky from 315 to 36 tons; northern Illinois increased from 3,792 to 6,788 tons. No production of lead or zinc was reported from Iowa mines in 1919.

LEAD AND ZINC PRODUCTION, BY REGIONS.

The productive lead and zinc territory in the Central States naturally falls into seven regions, three of which are not limited to any single State. For statistical purposes the tables showing the production of lead and zinc by States are necessary and are so given. For practical purposes, however, it is desirable to compile the production by the natural regions irrespective of State lines.

The seven regions are, in order of size of output: (1) the Joplin region, comprising the district in southwestern Missouri, southeastern Kansas, and northeastern Oklahoma; (2) southeastern Missouri, containing the great deposits of disseminated lead; (3) the upper Mississippi Valley region, including all the lead and zinc mines in southwestern Wisconsin, Iowa, and northwestern Illinois; (4) northern Arkansas; (5) the fluorspar region in southern Illinois and northern Kentucky; (6) central Missouri; (7) the Arbuckle Mountain region in southern Oklahoma.

The southeastern Missouri region produced about 67 per cent of the lead output of the Central States and about 37 per cent of the primary lead recovered from domestic ore smelted or refined in the United States in 1919. The Joplin region produced 30 per cent of the lead and 84 per cent of the zinc of the Central States in 1919, and was much the largest producer of zinc in the United States, yielding about 57 per cent of the total zinc production from domestic ores in 1919, as against 48 per cent in 1918. The upper Mississippi Valley region produced 2.5 per cent of the lead and 15.6 per cent of the zinc in the Central States in 1919.

The lower zinc content of the zinc concentrates produced in the upper Mississippi Valley region is clearly indicated by the fact that although the mines in the region yielded about 25.2 per cent of the total output of zinc concentrates of all classes the recoverable zinc content of such concentrates was only about 15.6 per cent of the recoverable zinc from mines in the Central States.

The lead content of the galena concentrates shipped from the upper Mississippi Valley region averaged 74.6 per cent, and that of the concentrates from the Joplin region averaged 79.6 per cent.

Mine production of lead and zinc in the Central States in 1919.

Region.	Concentrates.				
	Lead.[a]		Zinc.[b]		Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Joplin	89,595	$6,077,695	488,370	$20,819,081	$26,896,77
Southeastern Missouri[c]	229,687	11,590,977	231	6,576	11,597,55
Upper Mississippi Valley	7,805	496,910	165,116	3,543,717	4,040,62
Kentucky-southern Illinois	835	51,334	120	3,600	54,93
Northern Arkansas	35	2,400	510	18,170	20,57
Total, 1919	327,957	18,219,316	654,347	24,391,144	42,610,46
1918	376,694	29,806,510	667,152	28,711,449	58,517,95

Region.	Metal.				
	Lead.		Zinc.		Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	
Joplin	71,287	$7,556,422	257,514	$37,597,044	$45,153,46
Southeastern Missouri[c]	157,158	16,658,748	72	10,512	16,669,26
Upper Mississippi Valley[d]	5,819	616,814	47,553	6,942,738	7,559,55
Kentucky-southern Illinois	586	62,116	36	5,256	67,37
Northern Arkansas	28	2,968	189	27,594	30,56
Total, 1919	234,878	24,897,068	305,364	44,583,144	69,480,21
1918	264,635	37,578,170	302,662	55,084,484	92,662,65

[a] Includes both galena and lead carbonate concentrates.
[b] Includes sphalerite, zinc carbonate, and zinc silicate concentrates.
[c] Includes a small production from the central Missouri region.
[d] Includes Iowa, northern Illinois, and Wisconsin.

Mineral Resources for 1914 contains brief reviews of the history of lead and zinc mining in the Central States, the yearly production of each State for the period 1907 to 1914, inclusive, and historical notes and estimates of the total production of lead and zinc in each State before 1907.

ARKANSAS.

PRODUCTION.

The value of the recoverable lead and zinc from Arkansas mines, which had increased from $801,754 in 1915 to $1,430,668 in 1917, was only $30,562 in 1919. The decrease in shipments was caused almost entirely by the lower price of zinc concentrates.

The production of galena was less than one-fourth of that in 1918, and the total yield was small as compared with that of other regions. The shipments of zinc carbonate and zinc silicate concentrates in 1919 were one-fourth as large as in 1918.

Mine production of lead and zinc in Arkansas, 1907–1919.[a]

Year.	Ores.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Silicate and carbonate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1919	35	$2,400	.....	.....	510	$18,170	28	$2,968	189	$27,594
1918	155	13,594	310	$16,450	2,156	68,333	120	17,040	951	173,082
1917	474	47,593	916	57,824	17,053	650,585	382	65,704	6,691	1,364,964
1916	339	28,097	1,670	112,726	16,609	940,224	272	37,536	6,815	1,826,420
1915	79	4,961	606	41,341	7,925	408,079	63	5,922	3,209	795,832
1914	52	2,408	743	19,406	1,143	25,187	41	3,198	608	62,016
1913	23	1,179	594	16,916	680	15,050	18	1,584	478	53,536
1912	39	2,180	1,419	56,235	462	11,231	31	2,790	748	103,224
1911	80	4,321	1,407	40,425	183	4,239	64	5,760	664	75,696
1910	80	3,714	1,857	74,136	128	2,641	63	5,544	994	107,352
1909	30	1,800	896	33,948	98	2,736	24	2,064	510	52,080
1908	18	985	516	18,270	939	21,469	15	1,260	605	56,870
1907	15	800	538	15,233	663	16,210	12	1,272	474	55,932

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses of zinc but not of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades and that of zinc from the average sales price of all grades reported by the smelters.

Tenor of lead and zinc ore and concentrates produced in Arkansas in 1918 and 1919.

		1918	1919
Total crude ore	short tons	37,000	5,800
Total concentrates in crude ore:			
Lead	per cent	0.42	0.60
Zinc	do	6.62	8.80
Metal content of crude ore:			
Lead	do	.32	.49
Zinc	do	2.86	3.71
Average lead content of galena concentrates	do	77.4	80.0
Average zinc content of sphalerite concentrates [a]	do	59.0	.....
Average zinc content of zinc silicate and carbonate [a]	do	40.6	42.0
Average value per ton:			
Galena concentrates		$87.70	$68.57
Sphalerite concentrates		$53.07	.....
Zinc silicate and carbonate		$31.69	$35.63

[a] Includes some mixed carbonate and sphalerite.

NORTHERN ARKANSAS.

Considerable prospecting and some mining were carried on in northern Arkansas for many years, but the present development has mainly been accomplished since 1899, when there was a great rush to that field. The mines are principally in Boone and Marion counties and in the adjoining portions of Searcy and Newton counties, though there are also numerous mines and prospects in Baxter, Izard, Sharp, Lawrence, and other counties to the east, and deposits have been worked in Washington and Sevier counties, on the extreme western border of the State.

The ores are galena, sphalerite, and smithsonite, and the concentrates produced are generally of high grade and free from or very low in iron or lime. The sphalerite has frequently assayed 2 or 3 per cent above the price basis of 60 per cent metallic zinc content. The sphalerite and smithsonite are shown by analysis to contain appreciable quantities of cadmium, especially in a yellow variety of smithsonite, known locally as "turkey fat," which shows as high as 0.8 per cent of cadmium. The ore bodies occur in fissures or crevices, in fault breccias, and in solution breccias. The ore deposits are for the most part found in limestone of early Ordovician age, but some also are found in the Boone limestone of Mississippian (lower Carboniferous) age.

Some mixed sphalerite and zinc carbonate concentrates were sold, and these shipments are given under carbonate. As very little ore was milled in 1919 and nearly all the recoveries were made from hand-cobbed ore the recovery from ore treated is only estimated.

Most of the lead and zinc mines in Arkansas were not operated in 1919, and few of those from which concentrates were shipped were operated steadily. Several of the larger mine operators shut down their zinc properties in northern Arkansas and engaged in the mining of manganese ores near Batesville, Ark., and the scarcity of labor and high cost of supplies resulted in closing nearly all the zinc carbonate mines. Most of these mines have inexpensive equipment, no water to pump, and no leases requiring steady operation, so that work could be suspended until better prices were offered for zinc ores. These conditions explain why the reduction in the output of

lead and zinc from Arkansas mines was proportionately greater than in the other regions of the Central States.

The estimated quantity of ore treated decreased from 37,000 tons in 1918 to 5,800 tons in 1919, and the average recovery of concentrates from such ore increased from 7.04 per cent to 9.40 per cent.

There was no mine which yielded more than 100 tons of concentrates, and the entire production came from mines worked on a small scale, as is shown by the fact that the total shipments of all classes of concentrates, amounting to 545 tons, was derived from about 17 mines or prospects.

The shipments of lead concentrates from mines decreased from 155 tons in 1918 to 35 tons in 1919. There was no sphalerite sold in 1919. The sales of zinc carbonate concentrates decreased in quantity from 2,156 tons in 1918 to 510 tons in 1919, and the value decreased from $68,333 to $18,170. The recoverable lead content of galena concentrates shipped in 1919 amounted to 28 tons, valued at $2,968, and the recoverable zinc from zinc concentrates was 189 tons, valued at $27,594. Mines in Marion, Boone, and Newton counties produced all the zinc concentrates shipped in 1919, and mines in Newton County produced all the galena concentrates.

The shipments from Boone County were 80 tons of zinc carbonate. The shipments of zinc carbonate, which were about 1,000 tons less than in 1918, were mainly from mines in the vicinity of Zinc, especially from lessees on the Coon Hollow and Almy lands. A description of the mining properties near Zinc was recently written by Tom Shiras.[2]

From mines principally in the Cave Creek district, in the eastern part of Newton County, and the Ponca and Jasper districts, in the western part, were shipped 35 tons of galena and 78 tons of zinc carbonate.

The total shipments from mines in Marion County in 1919 amounted to 352 tons of zinc carbonate concentrates, which was 160 tons of sphalerite and 152 tons of zinc carbonate less than in 1918.

None of the mines were operated steadily, and no large shipments were made. The mines at Rush, which were large producers in 1917, shipped only about 140 tons of zinc carbonate in 1919. Among the producing properties were the Morning Star, Beulah, and Edith.

ILLINOIS.

PRODUCTION.

In Mineral Resources for 1914 were given a historical review and a bibliography of the literature relating to the mining of lead and zinc in the northern and southern districts of the State of Illinois. Estimates were also given of the total quantity of concentrates and metal produced to the end of 1914.

[2] Shiras, T., Operations at the Zinc camp, Ark.: Eng. and Min. Jour., Apr. 5, 1919, pp. 607–608.

Mine production of lead and zinc in Illinois in 1919.

District.	Ores.				Lead.		Zinc.	
	Lead concentrates.		Zinc concentrates.		Quantity (short tons).	Value.	Quantity (short tons).	Value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value				
Northern Illinois	2,159	$137,115	25,034	$491,579	1,605	$170,130	6,788	$991,048
Southern Illinois	715	44,084	.....	.....	500	53,000	.....	.....
Total, 1919	2,874	181,199	25,034	491,579	2,105	223,130	6,788	991,048
1918	3,096	265,248	13,128	377,100	2,273	322,766	3,792	690,144

Mine production of silver in southern Illinois, 1907–1919.

Year.	Silver.		Lead concentrates, silver bearing.		Year.	Silver.		Lead concentrates, silver bearing.	
	Quantity (fine ounces).	Value.	Quantity (short tons).	Ounces of silver per ton.		Quantity (fine ounces).	Value.	Quantity (short tons).	Ounces of silver. per ton.
1907	2,852	$1,882	497	5.74	1914	2,112	$1,168	308	6.86
1908	2,051	1,087	359	5.71	1915	3,864	1,959	641	6.03
1909	1,011	526	259	3.90	1916	5,684	3,740	874	6.50
1910	2,022	1,092	398	5.08	1917	7,186	5,921	1,239	5.80
1911	3,036	1,609	482	6.25	1918	8,171	8,171	1,228	6.65
1912	4,731	2,909	748	6.31	1919	4,440	4,973	715	6.16
1913	3,541	2,139	507	7.00					

Tenor of lead and zinc ore and concentrates produced in Illinois, 1918 and 1919.

	1918	1919
NORTHERN ILLINOIS.		
Total crude ore.....short tons..	280,900	404,000
Total concentrates in crude ore:		
Lead.....per cent..	.66	.53
Zinc.....do....	4.67	6.19
Metal content of crude ore:		
Lead.....do....	.50	.40
Zinc.....do....	1.60	2.07
Average lead content of galena concentrates.....do....	75.5	74.5
Average zinc content of sphalerite concentrates.....do....	35.7	33.5
Average value per ton:		
Galena concentrates	$87.09	$63.51
Sphalerite concentrates	$28.72	$19.63
SOUTHERN ILLINOIS.		
Average lead content of galena concentrates.....per cent..	70.0	70.0
Average value per ton of galena concentrates	$83.52	$61.66

The lead concentrates produced in southern Illinois are recovered in concentrating the fluorspar. To speak of the total crude ore raised as crude lead ore would be misleading. No attempt has been made, therefore, at calculating the quantity or the tenor of the crude ore.

The value of the mine production of silver, lead, and zinc in Illinois in 1919 was $1,219,151, as compared with $1,021,081 in 1918. The lead concentrates produced amounted to 2,874 short tons, which was

222 tons less than in 1918, and the recoverable lead content decreased from 2,273 tons in 1918 to 2,105 tons in 1919.

The output of sphalerite concentrates increased from 13,128 tons in 1918 to 25,034 tons in 1919, the recoverable zinc content of the concentrates increased from 3,792 tons in 1918 to 6,788 tons in 1919, and the value increased $300,904.

The silver recovered from lead concentrates amounted to 4,440 fine ounces, valued at $4,973, against 8,171 fine ounces, valued at $8,171, in 1918.

The lead and zinc deposits of Illinois fall into two distinct regions marked by different mineral association and structural environment. Those of southern Illinois belong to the Kentucky-Illinois fluorspar district; those of northern Illinois belong to the upper Mississippi Valley region.

NORTHERN ILLINOIS.

The lead and zinc mines of northern Illinois are all in Jo Daviess County, the extreme northwestern county of the State. The ores have the same structural relations as in the upper Mississippi district generally—that is, they occur disseminated through the limestone, or in openings in it called "crevices," "pitches," or "flats," depending on their attitude to the horizontal. These openings have, in general, an east and west trend, known as their "range." The ore bodies are sometimes continuous for long distances along these "ranges," which for that reason largely control the prospecting, both by shafts and by drilling. The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age.

The ores are galena, smithsonite, and sphalerite, though the first two are much less common now than formerly, when the deposits worked were mostly shallow and above water level. In early years the galena ores only were mined and the ore was taken from shallow pockets in quantities ranging from a few tons to several thousand tons.

Although the lead output of northern Illinois, Wisconsin, and Iowa has been large in the past and the ores have been smelted near the mines,[3] the output in recent years has been comparatively small and no ores have been smelted in those States.[4] The galena is practically nonargentiferous, and the zinc ores are not known to contain cadmium. Iron pyrites is very commonly associated with the ores, generally in such quantity as to necessitate roasting and magnetic separation.

As none of the operators in the Sand Prairie district or in the Elizabeth district reported any production in 1919, the entire output of northern Illinois is included under the Galena district, which comprises the mines from the vicinity of Fever River to the Wisconsin State line.

The production of lead concentrates was 2,159 tons, valued at $137,115, as compared with 1,868 tons, valued at $162,684, in 1918.

[3] Cox, G. H., Lead and zinc deposits of northwestern Illinois: Illinois Geol. Survey Bull. 21, p. 14, 1914.

[4] Pulsifer, H. B., History of lead smelting in Wisconsin: Min. and Eng. World, May 2, 1914, p. 821.

There were 25,034 tons of sphalerite concentrates, valued at $491,579, produced in 1919, an increase of 11,906 tons in quantity and of $114,479 in value.

The crude ore mined increased from 280,900 tons in 1918 to 404,000 tons in 1919. The average recovery of zinc concentrates from the ore milled increased 1.39 per cent, and the percentage of lead was less than in 1918.

The average zinc content of the sphalerite concentrate decreased from 35.7 per cent in 1918 to 33.5 per cent in 1919.

The largest production of lead and zinc concentrates in northern Illinois in 1919 was derived from the old Marsdon-Black Jack mine of the Mineral Point Zinc Co. The mill has a capacity of 600 tons in 24 hours and is driven by electric power. The mine is equipped with a steel head frame and a double-compartment mill shaft, and the ore is hoisted in skips. The Graham mine, of the Vinegar Hill Zinc Co., was the second largest producer of sphalerite and the North Unity mine the largest producer of galena in 1919. The Osborne sublease, on the Graham land, had a good production of lead taken from levels opened by shafts 45 to 60 feet in depth. The Burr Mining Co. operated the Blewett mine and had a large output of sphalerite. Lead ore taken from shallow levels was shipped from the White Rose, Big Indian, and Eadie mines.

SOUTHERN ILLINOIS.

The lead and zinc deposits of southern Illinois are found in Pope and Hardin counties in rocks of Mississippian age in the northern extension of the Kentucky-Illinois fluorspar district.

The principal product of the mines in recent years has been fluorspar, and the yield of galena is small compared with the output from other districts in the Central States. The total production of galena concentrates for southern Illinois, 1906 to 1919, inclusive, has been 8,458 tons, most of which has been shipped from the Fairview and Rosiclare mines. The shipments of zinc ores from the district have been comparatively small and scattered. The only recorded shipments of zinc carbonate were made from the Empire mine in 1903 or 1904, and in 1916 four companies made shipments aggregating 103 tons.

The structural relation and the mineralogic association are similar to those of the deposits of western Kentucky and in striking contrast to those of the deposits of northern Illinois. The ores occur in fissure veins, in association with jointing and faulting. The mines have been worked to depths of 300 and 500 feet without disclosing any decrease in the dimensions of the ore bodies. Dikes and sheets of lamprophyre and dikes of mica peridotite occur in the vicinity, but not in direct connection with the ore deposits. Galena is the most important metallic mineral. Formerly, and nearer the surface, large bodies of galena were worked, but it is at present produced incidentally in the concentration of the fluorspar. For this reason it would be misleading to give the quantity of crude ore. As the district is not reached by railway, the product of the mines is dependent on river transporation.

The galena of southern Illinois is notably argentiferous as compared with the rest of the Mississippi Valley ores, the silver content

being as much as 14 fine ounces per ton of lead concentrate and averaging for the last seven years from 5 to 7 ounces per ton of lead concentrate. Sphalerite, or zinc blende, is the next important metallic mineral, but it occurs much less plentifully than galena. It is recovered as zinc middlings in the concentration of the fluorspar. The difficulty of making a clean separation of the zinc middlings has kept down the production of zinc. None has been sold from southern Illinois in the last 10 years. The principal vein minerals are fluorspar, calcite, and barite.

The shipments of galena concentrates decreased from 1,228 tons in 1918 to 715 tons in 1919, and the silver content recovered in treating the concentrates decreased from 8,171 ounces in 1918 to 4,440 ounces in 1919. The average lead content of the concentrates was 70 per cent in 1918 and 1919. The average silver content per ton recovered from lead concentrates decreased from 6.65 ounces in 1918 to 6.16 ounces in 1919.

The Fairview Fluorspar & Lead Co., which was much the largest producer of galena, operated on the Good Hope vein, which was first developed in 1862.

The Rosiclare Lead & Fluorspar Co. operates on an ore body which is probably continuous with that of the Fairview. The main shaft at the Rosiclare has reached a depth of 520 feet, and the other two shafts operated are 300 and 400 feet deep. The steel and concrete mill, entirely fireproof, is designed to handle 500 tons a day and is provided with special facilities for saving the lead and zinc both by jigs and by tables.

IOWA.

The lead and zinc deposits of Iowa extend along Mississippi River for nearly 80 miles, in Dubuque, Clayton, and Allamakee counties. They are found in the Galena dolomite, of Ordovician age.

In early days the Dubuque mines were the most important source of lead in the United States, and in later years the mines, especially those in the vicinity of Durango, yielded considerable quantities of zinc-carbonate ore.

The ore deposits of the Dubuque district occur in crevices and in caves or "openings" along these crevices. Of these openings there are five or six, the "top," "middle," and "third" being the most prolific of ore. The "flats" and "pitches," common in the Wisconsin mines, have been found in only one or two places in Iowa. The crevices have an east-west trend and sometimes extend considerable distances, being mined at different places, in which case they are known as "ranges."

No shipments of lead or zinc concentrates from mines in Iowa were reported in 1919.

KANSAS.

PRODUCTION.

Mine production of lead and zinc in Kansas, 1919.[a]

District.	Ores.				Metal content.			
	Lead concentrates.		Zinc concentrates.		Lead.		Zinc.	
	Galena.		Sphalerite.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Badger-Peacock	139	$8,752	980	$42,867	110	$11,660	512	$74,752
Lawton-Waco (in Kansas)	32	2,609	9,000	400,356	25	2,650	4,898	715,108
Blue Mound-Baxter Springs	13,522	925,346	76,470	3,403,032	10,899	1,155,294	41,456	6,051,700
Galena	331	20,714	1,506	55,005	249	26,394	776	113,296
Total, 1919	14,024	957,421	87,956	3,901,260	11,283	1,195,998	47,636	6,954,856
1918	9,083	825,703	55,979	2,937,644	7,252	1,029,784	30,197	5,495,854

[a] In calculating the metal content of the ores from assays, allowance has been made for smelting losses of zinc but not of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price for all grades and that of the zinc from the average sales price of all grades reported by the smelters.

Tenor of lead and zinc ore and concentrates produced in Kansas, 1918 and 1919.

		1918	1919
Total crude ore	short tons	1,025,400	1,391,600
Total concentrates in crude ore:			
Lead	per cent	0.88	1.01
Zinc	do	5.46	6.32
Metal content of crude ore:			
Lead	do	.70	.80
Zinc	do	3.27	3.80
Average lead content of galena concentrates	do	79.9	80.0
Average zinc content of sphalerite concentrates	do	59.9	60.1
Average value per ton:			
Galena concentrates		$90.90	$68.27
Sphalerite concentrates		$52.48	$44.35

The lead and zinc deposits of Kansas, so far as developed, are limited to the southeastern portion of the State, in Cherokee County. They comprise the western extension of the ore deposits of the Joplin region and display the general characteristics of that area, except that here typical sheet-ground deposits have not been extensively developed. The ores are galena and lead carbonate, sphalerite or zinc blende, and zinc carbonate and silicate. The galena is practically nonargentiferous, carrying but a small fraction of an ounce of silver to the ton of lead concentrates.

It is difficult to obtain the production for early years or to segregate the Kansas ores from those produced in the adjoining portion of the Joplin region in Missouri. If to the figures for the years 1886 to 1903 obtained and published by the State Geological Survey

of Kansas[5] are added those for the years 1904 to 1919, published by the United States Geological Survey, a total output of 1,228,182 tons of zinc concentrates and of 176,475 tons of lead concentrates is shown as the approximate production of Kansas for the years 1886 to 1919, inclusive.

The older mining camps at Lawton, Galena, and Badger produced less than one-half as much zinc and lead in 1919 as in 1918, but this decrease was more than balanced by the greatly increased production from the Blue Mound-Baxter district, an extension of the Miami field, and by the output of the new Waco camp on the Kansas-Missouri State line.

The value of the mine production of lead and zinc in Kansas in 1919 was $8,150,854, against $6,525,638 in 1918.

The value of the recoverable lead in galena concentrates shipped from Kansas mines in 1919 was $1,195,998. The production of lead concentrates increased from 9,083 tons in 1918 to 14,024 tons in 1919, and the metal content from 7,252 to 11,283 tons. The percentage of lead concentrates in crude ore milled increased from 0.88 per cent in 1918 to 1.01 per cent in 1919. This increase was due to the larger recoveries of lead from the new mines near Blue Mound, whose mills treated about 84 per cent of all the crude ore mined in Kansas in 1919.

The average lead content of the galena concentrates sold was 0.1 per cent more in 1919 than in 1918, and the average price received for such concentrates was $68.27 a ton, against $90.90 in 1918.

The production of sphalerite concentrates in 1919 was 87,956 tons, valued at $3,901,260, an increase of 31,977 tons in quantity and of $963,616 in value, as compared with 1918. The average zinc content of the sphalerite concentrates shipped was 0.2 per cent more in 1919 than in 1918. Owing to the much richer ore mined in the new Waco and Blue Mound districts and to lower ore prices and higher costs of mining, the total percentage of sphalerite concentrates recovered from crude ore treated in Kansas increased from 5.46 per cent in 1918 to 6.32 per cent in 1919.

Badger-Peacock district.—The production of the Badger-Peacock district, including several shipments of galena from some prospects at Pershing, west of Badger, was 139 tons of galena and 980 tons of sphalerite, against 234 tons of galena and 1,041 tons of sphalerite in 1918.

Lawton-Waco district.—Nearly all the output of the Lawton-Waco district in 1919 was from the mines in Kansas, near Waco, as the only producing property at Lawton—the Eastern Lead & Zinc Co.—preferred operating on a small scale to exhausting its ore under prevailing conditions. The total production of the district (including only those mines near Waco in Kansas) was 32 tons of galena and 9,000 tons of sphalerite, as compared with 31 tons of galena and 7,830 tons of sphalerite in 1918. The total output of the Waco district, lying partly in Missouri and partly in Kansas, in 1919 was 210 tons of galena and 25,136 tons of sphalerite, against 250 tons of galena and 13,166 tons of sphalerite in 1918.

Galena district.—The production of lead concentrates in the Galena district in 1919 was 331 tons, valued at $20,714, as compared

[5] Haworth, Eramus, and others, History, geography, geology, and metallurgy of Galena-Joplin lead and zinc: Kansas Univ. Geol. Survey, vol. 8, 1904.

with 1,193 tons, valued at $98,832, in 1918. The shipments of sphalerite concentrates amounted to 1,506 tons, a decrease of 5,129 tons; and, owing to the lower prices paid for zinc concentrates, the total value of the zinc concentrates was $224,665 less in 1919 than in 1918. The metal content of the lead concentrates was 249 tons in 1919, against 935 tons in 1918. The average zinc content of sphalerite sold in the Galena district in 1919, according to the reports of the operators, was 57.3 per cent.

Blue Mound-Baxter district.—Although retarded considerably by adverse conditions prevailing in all mining regions, the activity in part of Cherokee County, Kans., caused by the progressive northerly development of the Miami district continued throughout 1919. Drilling was not as active as in 1918, but many mining shafts were sunk and mills constructed, and under very adverse conditions the production of lead and zinc increased in a greater ratio than in any other mining district in the United States. In fact, much of the development was necessary in order to fulfill the terms of the leases. Most of the output in 1919 came from mines situated north and northwest of the Picher area and close to the State line, although several mines north of Hockerville, Okla., and east of Blue Mound produced lead and zinc concentrates in 1919. A number of shafts were sunk west of Baxter Springs and several mills were built or under construction.

The shipments of concentrates, which amounted to 7,625 tons of galena and 40,473 tons of sphalerite in 1918, increased to 13,522 tons of galena and 76,470 tons of sphalerite in 1919. The average lead content of the galena sold was more than 80 per cent, and the zinc content of the sphalerite concentrates sold was 60.2 per cent. The crude ore (dirt) milled yielded 7.67 per cent in concentrates, and at some mines the recovery was more than 10 per cent. Of this production in 1919 all but 14 per cent was shipped by mines west and northwest of Blue Mound. As in 1918, the largest producing mines were the Blue Mound, Blue Diamond, and Barr (Vinegar Hill).

KENTUCKY.

PRODUCTION.

Lead and zinc deposits are found in both central and western Kentucky. None of the mines in Franklin, Mercer, Scott, Owen, or Henry counties, in the central districts, reported any lead or zinc concentrates shipped in 1919. The mines in the fluorspar region of western Kentucky are chiefly in Crittenden, Caldwell, and Livingston counties and form a continuation of the southern Illinois lead and zinc region. The earliest available records of the occurrence of fluorspar and the associated galena in the Kentucky-Illinois region appeared in the first, second, and third volumes of the American Journal of Science, published in 1818, 1820, and 1821.[6]

The presence of zinc blende was recognized in 1854–1857 during the first geological survey of the State of Kentucky by David Dale

[6] Ulrich, E. O., and Smith, W. S. T., The lead, zinc, and fluorspar deposits of western Kentucky: U. S. Geol. Survey Prof. Paper 36, pp. 16–17, 1905.

Owen and his assistant, Sidney S. Lyon. The first lead smelter using galena from Kentucky was erected by the River Valley Mining Co. at the Royal mine [7] about 1870.

Considerable quantities of galena ores have been produced in former years, but at the present time lead is obtained solely as a by-product in the recovery and concentration of fluorspar, which is the principal economic mineral. The galena recovered is argentiferous, the silver content varying from a very small quantity to more than 3 ounces a ton, but no recovery of this silver content has been reported by the smelters during the last eight years. The lead concentrate shipped in any one year from Kentucky does not necessarily represent the actual recovery of lead from fluorspar mined in that year, for, being merely accessory to the fluorspar and produced in small quantities, it is frequently held until a considerable quantity has accumulated or until lead prices are high.

Mine production of lead and zinc in Kentucky, 1907–1919.

Year.	Ores.						Metal content.			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Zinc carbonate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1919	120	$7,250	.....	.....	120	$3,600	86	$9,116	36	$5,256
1918	255	21,066	.....	.....	927	30,390	185	26,270	315	57,330
1917	184	15,415	.....	.....	2,299	78,368	123	21,156	751	153,204
1916	227	16,868	125	$6,407	2,923	126,875	153	21,114	1,096	293,728
1915	370	17,103	.....	.....	2,172	106,079	251	23,594	764	189,472
1914	26	800	27	1,120	644	12,168	16	1,248	230	23,460
1913	40	1,422	198	5,206	696	13,811	22	1,936	327	36,624
1912	151	6,827	498	25,391	750	16,006	106	9,540	491	67,758
1911	.....	.....	.....	.....	467	10,604	.....	.....	158	18,012
1910	56	1,980	.....	.....	30	300	41	3,608	6	648
1909	12	620	.....	.....	150	1,701	10	860	64	6,912
1908	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1907	54	2,850	.....	.....	.....	.....	34	3,604	.....	.....

The shipments of zinc carbonate decreased from 927 tons, valued at $30,390, in 1918 to 120 tons, valued at $3,600, in 1919. The estimated recoverable zinc content in 1919 was 36 tons, valued at $5,256.

The shipments of galena concentrates reported in 1919 were 120 tons, valued at $7,250, compared with 255 tons, valued at $21,066, in 1918. The average lead content was 72 per cent, compared with 72.1 per cent in 1918. The recoverable metallic content of the galena in 1919 was 86 tons, valued at $9,116.

The total value of the lead and zinc concentrates shipped from Kentucky mines was $10,850, as against $51,456 in 1918.

The principal seller of galena concentrates was the Kentucky Fluorspar Co.

The American Spar Co. operated the Hudson mine of the Eagle Fluorspar Co., near Salem, in Livingston County, and shipped most

[7] Fohs, F. J., Fluorspar deposits of Kentucky: Kentucky Geol. Survey Bull. 9, 1907.

of the zinc carbonate. The ore was taken from workings about 85 feet in depth and treated in log washers before shipment.

MICHIGAN.

By F. Begeman.

PRODUCTION.

In 1919 the mines of Michigan produced 178,826,486 pounds of copper, valued at $33,261,726, and 441,430 fine ounces of silver, valued at $494,402, a total value in copper and silver of $33,756,128. This was a decrease of $22,771,491 in value from the production of 1918.

The average selling price of copper per pound for 1919 was $0.186; for 1918 it was $0.247. The average selling price of silver per fine ounce for 1919 was $1.12; for 1918 it was $1. Owing to the decrease in the price of copper, there was a decrease from $4.95 in 1918 to $4.33 in 1919 in the estimated average value of copper per ton of ore or "rock" treated.

The smelter production or the output of refined copper for 1919 was 177,594,135 pounds, as compared with 231,096,158 pounds in 1918. The difference between the mine and the smelter production is due to the fact that the quantity of concentrates or "mineral" produced is not the same as the quantity smelted. A company may produce either more or less "mineral" than it smelts during the year.

Mine production of silver, copper, concentrates or "mineral," and ore "rock" in Michigan in 1918 and 1919.

Year.	Silver (fine ounces).	Copper.			Concentrates ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1918	509,467	[a] 226,794,139	19.2	0.96	[b] 364,837,334	62.2	11,321,365
1919	441,430	[a] 178,826,486	22.1	1.10	[b] 299,472,036	59.7	7,690,253
Increase or decrease, 1919	−68,037	−47,967,653	+2.9	+.14	−65,365,298	−2.5	−3,631,112

[a] Includes copper from sands.
[b] Includes "mineral" from sands.

Value of silver and copper produced at Michigan mines in 1918 and 1919.

Year.	Silver.	Copper.		Combined silver and copper.
		Total.	Per ton of ore or "rock."	
1918	$509,467	$56,018,152	$4.95	$56,527,619
1919	494,402	33,261,726	4.33	33,756,128
Decrease	15,065	22,756,426	.62	22,771,491

The entire Michigan output of copper and silver comes from the Keweenaw district. Both metals occur native in lodes remarkable for their great extent and uniformity. These lodes may be divided into two general classes—the amygdaloid, in which the metals occur together with gangue minerals, such as epidote, calcite, and zeolites, in the cellular portions of lava flows; and the conglomerate, in which the metals and gangue minerals cement and to some extent replace the pebbles forming the conglomerate. Native copper and copper minerals occur in fissures in the district, but the present output from this type of deposit is small. The ore ("rock")[8] is of low grade and requires milling, which produces concentrate ("mineral") carrying an average of about 65 per cent of copper. A small quantity of "barrel" and "mass" copper is sorted at the mines and sent direct to the smelters.

In 1919 a total of 7,690,253 short tons of ore ("rock") was milled, which yielded 299,472,036 pounds of concentrate ("mineral") and 178,826,486 pounds of copper.[9]

The average recovery of refined copper per ton of ore ("rock") milled in 1919 was 22.1 pounds, as compared with 19.2 pounds in 1918.

Silver amounting to 441,430 ounces was derived from the electrolytic treatment of 29,583,000 pounds of copper.

Three counties—Houghton, Keweenaw, and Ontonagon—contributed to the output of copper and silver. The following table shows the relative importance of these counties in output of copper and silver for 1918 and 1919:

Mine production of silver and copper in Michigan in 1918 and 1919, by counties.

County.	Silver (fine ounces).	Copper.			Concentrate ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1918.							
Houghton	453,957	[a] 173,371,829	19.1	0.95	[b] 283,854,508	61.1	8,604,767
Keweenaw	9,323	42,703,494	19.7	.98	64,110,463	66.6	2,165,722
Ontonagon	46,187	10,718,816	19.5	.97	16,872,363	63.5	550,876
Total and average	509,467	226,794,139	19.2	.96	364,837,334	62.2	11,321,365
1919.							
Houghton	393,642	[a] 138,110,856	22.3	1.11	[b] 238,754,196	57.8	5,777,969
Keweenaw	17,552	33,830,487	21.8	1.09	48,535,790	69.7	1,552,916
Ontonagon	30,236	6,885,143	19.2	.96	12,182,050	56.5	359,368
Total and average	441,430	178,826,486	22.1	1.10	299,472,036	59.7	7,690,253

[a] Includes copper from sands. [b] Includes "mineral" from sands.

[8] Some of the terms used to designate the different materials entering into the mining industry in the Lake district differ from those employed in any other part of the country. Ore is known as "rock" or (if unmined) "copper ground"; the product of concentration is known as "mineral"; and the term "ore" is used to designate the copper minerals (arsenides and sulphides) other than native copper that occur to a limited extent in the district. Large bodies of native copper are known as "mass" and smaller ones as "barrel work." In this report the local terms will be used, as it does not seem desirable to employ the more usual terms to the exclusion of the local, and a mixture of the two is confusing.

[9] The figures are based on the actual recovery of copper from the "mineral" smelted and the estimated recovery from the "mineral" that was not smelted during 1919.

HOUGHTON COUNTY.

In 1919 the mines of Houghton County produced 138,110,856 pounds of copper and 393,642 ounces of silver. The county occupies the central portion of the copper belt and contains 14 of the 21 mines that produced copper and 6 of the 10 mines that produced silver in 1919.

Ore ("rock") and concentrate ("mineral") produced and average yield in silver and copper in Houghton County in 1918 and 1919.

Year.	Silver (fine ounces).	Copper.			Concentrates ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1918	453,957	[a] 173,371,829	19.1	0.95	[b] 283,854,508	61 1	8,604,767
1919	393,642	[a] 138,110,856	22.3	1.11	[b] 238,754,196	57.8	5,777,969

[a] Includes copper from sands. [b] Includes "mineral" from sands.

Calumet & Hecla.—The Calumet & Hecla Mining Co. has been one of the most successful copper-mining companies in the world. To the end of 1919 the company had distributed $151,750,000 in dividends.

The company's ground contains three copper-bearing lodes—the Calumet & Hecla conglomerate, the Osceola amygdaloid, and the "Kearsarge" amygdaloid. A large percentage of the production in the past has come from the conglomerate lode, but with the decrease in copper content of this lode and its approaching exhaustion the mining from the amygdaloid lodes has increased.

The company's annual report shows the details of operation for 1919 as follows:

During 1919 there were 1,830,760 short tons of "rock" treated, yielding 43,776,194 pounds of copper, or an average of 23.91 pounds of copper to the ton of "rock." This compares with a yield of 20.42 pounds for 1918. The total cost per pound of copper was 20.16 cents for 1919, including 3.48 cents for depreciation. The recovery of copper from old sands added to the recovery from "rock" made a total production of 52,859,146 pounds. In 1919 the conglomerate lode produced 1,111,080 tons of "rock," yielding 32,895,816 pounds of copper, or an average of 29.61 pounds to the ton of "rock," as compared with 28 pounds for 1918.

The Osceola lode has an average width of 30 to 35 feet, though at some points it is much wider. The mineralization is confined principally to the hanging walls and the footwalls. The lode is opened by drift stopes along the hanging wall, where the mineralization is rather uniform. Crosscuts are extended to the footwall, where the mineralization is far less regular. In 1919 this lode produced 719,680 tons of "rock," yielding 10,880,378 pounds of copper, or 15.57 pounds to the ton of "rock." This compares with a yield of 11.58 pounds per ton of "rock" for 1918.

Development on the Kearsarge lode in Calumet & Hecla ground has not been encouraging, though the lode has proved very productive farther north. There was no output from the Kearsarge lode in 1919.

The reclamation plant for treating old tailings from Torch Lake treated 915,659 tons, having an average copper content of 13.88 pounds to the ton. A total of 9,082,952 pounds of copper was recovered, or an average of 9.92 pounds to the ton, at an average cost, exclusive of smelting and selling, of 7.62 cents a pound.

The following tables show the operation of the regrinding plant and the leaching plant:

Summary of operations of regrinding plant, Calumet & Hecla Mining Co., for the year 1919.

	From mine.	From old sands.
Ore treated.....tons..	581,583	714,359
Assay of heading.....per cent..	0.564	0.775
Assay of tailings.....do...	0.387	0.510
Refined copper produced.....pounds..	2,186,209	3,808,796
Refined copper produced per ton of ore treated.....do...	3.76	5.33
Cost per pound of copper, exclusive of smelting and selling.....cents..	7.22	5.58

Summary of operations of leaching plant, Calumet & Hecla Mining Co., for the year 1919.

Ore treated.....short tons..	1,070,300
Assay of headings.....per cent..	0.488
Assay of tailings.....do....	0.120
Refined copper produced.....pounds..	7,519,517
Refined copper produced per ton of ore treated.....do.....	7.03
Cost per pound of copper, exclusive of smelting and selling.....	6.44

Osceola.—In 1919 the Osceola Co. operated its three branches—the Osceola, the South Kearsarge, and the North Kearsarge. Since 1878 this company has distributed dividends to the amount of $17,660,225.

The Osceola branch lies directly south of the Calumet & Hecla and is worked on the Osceola amygdaloid. The property contains a part of the Calumet & Hecla conglomerate lode, but the only portion of it in Osceola ground that has been shown to carry copper in paying quantities was worked out in the early days of the mine. A total of 150,223 tons of "rock" was produced in 1919, yielding 2,365,226 pounds of copper, or an average of 15.74 pounds to the ton.

The North Kearsarge lies north of the Wolverine and is worked on the Kearsarge lode. This branch produced 465,034 tons of "rock," yielding 6,380,660 pounds of copper, or an average of 13.72 pounds to the ton.

The South Kearsarge lies south of the Wolverine and east of the Centennial on the Kearsarge lode. This branch produced 124,107 tons of "rock," yielding 2,078,445 pounds of copper, or an average of 16.75 pounds to the ton.

In 1919 the company treated 739,364 tons of "rock," producing 10,824,331 pounds of copper, an average yield of 14.6 pounds of refined copper to the ton of "rock." This compares with a yield of

13.3 pounds in 1918. The total cost of refined copper per pound was 18.08 cents for 1919, including 1.61 cents for depreciation.

Dividends were declared in 1919 to the amount of $288,450.

Centennial.—The Centennial ground lies north of the Calumet & Hecla and west of the South Kearsarge and the Wolverine. It contains parts of the Calumet & Hecla, Osceola, and Kearsarge lodes. The Kearsarge is the only one of proved value in the property, and to this lode operations are at present confined.

"Rock" to the amount of 87,688 tons was stamped during the year, producing 1,365,148 pounds of refined copper, or 15.57 pounds of refined copper to the ton of "rock" stamped. The average cost of refined copper per pound was 24.64 cents, which included 1.81 cents for depreciation.

Wolverine.—The Wolverine is between the North Kearsarge and South Kearsarge branches of the Osceola Co. Its operations are on the "Kearsarge" amygdaloid, though the West lode, parallel with the Kearsarge lode and about 80 feet to the west, has been opened to a small extent. The mine has the distinction of having the richest rock mined in the district. The operations of the Osceola lode have thus far proved disappointing. The Kearsarge lode in the Wolverine ground shows great uniformity of mineralization and is opened for the full length. In the upper levels the "rock" averaged from 16 to 18 pounds to the ton, but as the lower levels were opened it showed marked improvement. As the bottom limits are approached there is a notable decrease in the copper content of the rock.

During the fiscal year ending June 30, 1919, the company stamped 298,089 tons of "rock," which produced 7,339,025 pounds of "mineral," yielding 4,562,617 pounds of copper, or 15.306 pounds of refined copper to the ton of "rock" stamped. The total cost per pound of refined copper was 20.300 cents, including 3.761 cents for depreciation and depletion.

Since its organization to June 30, 1919, the company has produced 165,944,757 pounds of copper. Operations have resulted in profits amounting to $11,107,811, of which $10,260,000 has been paid in dividends. Three dividends paid during the fiscal year amounted to $150,000.

Franklin.—The Franklin and the Rhode Island, which is controlled by the Franklin, are southeast of the La Salle. The property carries several lodes, but in the past exploration has been confined principally to the "Pewabic" amygdaloid and the Allouez or "Albany and Boston" conglomerate.

In 1919 the company treated 109,565 tons of "rock," which yielded 1,062,879 pounds of copper.

Owing to shortage of labor, production was discontinued May 15, 1919. Since that time operations have consisted of development work only.

Quincy.—The Quincy mine is just north of the eastern arm of Portage Lake. The property is traversed by most of the lodes of the district but has derived its principal output in the past from the Pewabic lode, with a small quantity from the West lode.

Dividends to the amount of $440,000 were paid in 1919. Total disbursement in dividends from 1862 to 1919 amounted to $26,892,500.

In 1919 the company mined 960,393 tons of "rock," which yielded 32,800,590 pounds of "mineral" and 19,476,320 pounds of copper, an average of 20.28 pounds to the ton of rock.

Isle Royale.—The Isle Royale mine is south of the eastern arm of Portage Lake, near Houghton. The property contains several copper-bearing lodes, of which the Isle Royale is the main producer at present.

During 1919 "rock" amounting to 724,667 tons was treated, yielding 13,007,647 pounds of copper, or an average of 17.95 pounds of copper to the ton. The average cost per pound of copper was 15.80 cents, including 1.05 cents for depreciation.

Dividends were paid to the amount of $150,000.

Baltic, Champion, and Trimountain.—The Baltic, Champion, and Trimountain mines are on the Baltic lode southwest of Houghton and are under the management of the Copper Range Co. The Baltic is an exceptionally strong lode, having a stoping width varying from 15 to 80 feet. The lode has produced considerable "mass" copper and also contains veinlets of copper minerals, including chalcocite, boronite, and copper arsenides. These minerals are recovered in the mill, and the arsenides probably account in part for the arsenical character of the Copper Range output.

During 1919 a total of 235,832 tons of "rock" from the Baltic mine was stamped, producing 7,864,653 pounds of refined copper, or 33.35 pounds of refined copper to the ton of "rock" stamped. The cost per pound of refined copper was 17.53 cents.

A total of 171,995 tons of "rock" from the Trimountain was stamped, yielding 5,274,387 pounds of refined copper, or an average of 30.66 pounds to the ton. The average cost per pound of copper was 17.69 cents.

Since its organization the company has produced 127,426,098 pounds of copper at a profit of $5,115,069, of which $3,250,000 has been disbursed as dividends.

The Champion Copper Co. is controlled jointly by the Copper Range Co. and the St. Mary's Mineral Land Co. A total of 503,030 tons of "rock" was stamped, yielding 19,886,917 pounds of refined copper, a yield of 39.053 pounds to the ton of "rock" stamped. The cost of refined copper per pound was 11.62 cents.

From its organization to the end of 1919 the Champion Co. has produced 328,058,984 pounds of copper at a profit of $27,203,658, of which $25,250,260 has been disbursed as dividends.

Superior.—During the year 27,267 tons of "rock" from the Superior was stamped, producing 563,935 pounds of copper, or 20.68 pounds to the ton of "rock" stamped. The cost of copper was 36.84 cents a pound, including 1.93 cents for depreciation.

La Salle.—The La Salle Copper Co. produced 32,995 tons of "rock," yielding 340,719 pounds of copper, or an average of 10.326 pounds to the ton of "rock." The net cost per pound of copper was 40.86 cents, including 2.02 cents for depreciation.

Winona.—The Winona Copper Co. produced 39,654 tons of "rock," which yielded 942,660 pounds of "mineral" and 561,238 pounds of refined copper, an average of 14.153 pounds of refined copper to the ton of "rock" stamped.

Operations at the Winona mine were suspended about February 1, 1919, and resumed about August 1, 1919, making the total operating period six months.

Hancock.—The Hancock Consolidated Mining Co. treated 20,413 tons of "rock." Operations at the mine were suspended February 10, 1919, and not resumed for copper production during the rest of the year.

Houghton.—There were no mining operations on the Houghton Copper Co.'s property during 1919.

Other companies.—Other companies were active in development work.

KEWEENAW COUNTY.

In 1919 Keweenaw County produced 33,830,487 pounds of copper and 17,552 fine ounces of silver. The county occupies the northern portion of the copper belt.

Ore ("rock") and concentrate ("mineral") produced and average yield in silver and copper in Keweenaw County in 1918 and 1919.

Year.	Silver (fine ounces).	Copper.			Concentrate ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1918	9,323	42,703,494	19.7	0.98	64,110,463	66.6	2,165,722
1919	17,552	33,830,487	21.8	1.09	48,535,790	69.7	1,552,916

Ahmeek.—The Ahmeek mine lies north and east of the Allouez, on the Kearsarge lode.

A total of 756,870 tons of "rock" was stamped, yielding 17,223,111 pounds of refined copper, or 22.8 pounds of refined copper to the ton of "rock." The total cost per pound of refined copper was 14.02 cents, including 1.34 cents for depreciation.

During the year dividends were declared to the amount of $600,000. Total dividends to the end of 1919 amounted to $11,850,000.

Allouez.—The Allouez mine is north of the North Kearsarge. In 1919, as in other recent years, operations were confined to the Kearsarge lode. As this lode does not crop out on Allouez property, the shafts were started in the hanging wall at a steep angle and flattened to the tip of the copper-bearing bed just before reaching it. This plan avoids the expense of long crosscuts necessitated by vertical shafts.

A total of 235,312 tons of "rock" was stamped during 1919, yielding 3,749,984 pounds of refined copper, an average of 15.94 pounds of refined copper to the ton of "rock." The total cost per pound of refined copper was 21.55 cents, including 0.76 cents for depreciation.

Dividends declared during the year amounted to $100,000. Total dividends to April, 1919, amounted to $2,850,000.

Mohawk.—The Mohawk mine, east of the Ahmeek, carries the outcrop of the Kearsarge lode for more than a mile and also contains several cross fissures carrying arsenides of copper, which have been mined to a considerable extent.

A total of 560,734 tons of "rock" was stamped, yielding 18,257,500 pounds of "mineral" and 12,857,392 pounds of copper, or an average of 22.93 pounds to the ton of "rock." The total cost per pound of refined copper was 13.983 cents.

Since organization the Mohawk Co. has produced 182,543,444 pounds of copper, at a profit of $11,386,324, of which $9,125,000 has been disbursed as dividends. Dividends of $500,000 were paid in 1919.

ONTONAGON COUNTY.

In 1919 Ontonagon County produced 6,885,143 pounds of copper. This county contains the southwestern portion of the copper belt, which has not been so thoroughly developed as the other portions and consequently the geology is less understood than in the more northern counties. So far as developed, the lodes are more "bunchy" than to the north and have produced a relatively high percentage of mass copper. The output in 1919 was derived wholly from amygdaloid rock.

Ore ("rock") and concentrate ("mineral") produced and average yield in silver and copper in Ontonagon County in 1918 and 1919.

Year.	Silver (fine ounces).	Copper.			Concentrate ("mineral").		Ore ("rock") (short tons).
		Quantity (pounds).	Yield.		Quantity (pounds).	Yield (per cent).	
			Pounds per ton of ore ("rock").	Per cent.			
1918	46,187	10,718,816	19.5	0.97	16,872,363	63.5	550,876
1919	30,236	6,885,143	19.2	.96	12,182,050	58.5	359,368

Mass.—The Mass mine, which adjoins the Adventure on the southwest, carries six known copper-bearing amygdaloid lodes—the Knowlton, Mass, North Butler, Butler, Ogima, and Evergreen. In addition, the position of the property makes it probable that the newly discovered lodes in this part of the district may be present in Mass ground. The output for the year was derived from the main Butler lode and branches, the Evergreen lode, and the Ogima lode.

A total of 123,780 tons of "rock" was stamped in 1919, yielding 2,995,385 pounds of "mineral" and 1,963,178 pounds of refined copper, an average of 15.86 pounds of refined copper to the ton of "rock" stamped. The average cost per pound of refined copper, exclusive of depreciation, depletion, and construction, was 27.83 cents.

The mine was closed because of the increased cost of supplies, the shortage of labor, and the unfavorable conditions in the copper market.

Victoria.—The Victoria is the most southwesterly of the Lake mines that have made large production. The present output is obtained from the Forest lode. "Rock" amounting to 89,206 tons was stamped, yielding 1,843,228 pounds of "mineral" and 1,245,590 pounds of copper.

White Pine.—The White Pine Copper Co. treated 84,008 tons of "rock," yielding 1,979,268 pounds of copper, at a cost of 24.30 cents a pound, including 4.81 cents for depreciation.

The Michigan Copper Co. produced 62,373 tons of "rock," which with "mass" and "barrel" copper yielded 1,697,107 pounds of refined copper, an average of 27.21 pounds of refined copper to the ton of "rock" stamped. Developments during the year were very encouraging.

The South Lake Mining Co. was not operated in 1919.

Exploration and development work by other companies was on a small scale on account of the scarcity of labor and the high cost of materials.

MISSOURI.

PRODUCTION.

VALUE.

The value of the mine production of recoverable silver, copper, lead, and zinc in Missouri in 1919 was $22,315,628, compared with $37,953,016 in 1918. The value of copper increased $158,116, that of lead decreased $10,264,110, that of silver increased $54,310, and that of zinc decreased $5,585,704. The recoverable lead content of Missouri lead concentrates sold in 1919 was equal to 38 per cent of the smelter production of primary lead in the United States derived from domestic ores, and the recoverable zinc content from Missouri zinc concentrates sold in 1919 was 7 per cent of the primary zinc produced by smelters from domestic ores in 1919, as against 22.7 per cent in 1917 and 11.4 per cent in 1918.

SILVER AND COPPER.

Mine production of silver and copper in Missouri, 1910–1919.

Year.	Copper.		Silver.		Lead concentrates, silver bearing (short tons).
	Quantity (pounds).	Value.	Quantity (fine ounces).	Value.	
1910	94,452	$11,955	33,096	$17,872	35,00
1911	640,411	80,051	49,867	26,430	51,10
1912	440,725	72,719	35,438	21,794	31,18
1913	576,204	89,312	35,620	21,514	35,88
1914	44,463	5,914	61,168	33,826	61,99
1915	402,160	70,378	57,756	29,282	64,37
1916	386,200	95,005	129,450	85,178	88,06
1917	365,013	99,649	61,586	50,747	76,22
1918	577,665	142,683	[a] 46,939	46,939	52,00
1919	1,617,200	300,799	[b] 90,401	101,249	81,00

[a] 7,892 ounces of silver from copper ore or copper concentrates smelted.
[b] 29,480 ounces of silver from cobalt-nickel-copper ores.

For several years prior to 1913 the entire production of silver in Missouri had been derived from refining lead concentrates, but in each of the last seven years a small quantity of silver has been obtained from oxidized copper ore shipped from mines in Ste. Genevieve, Washington, and other counties. The quantities given in the fourth column of the foregoing table are those of recovered silver. The silver content of the lead ores is so small that it is disregarded in the assay and sale of the concentrates. For this reason the smelter reports must be relied on for the silver production. As may be seen by inspection of the table, the quantity of silver produced in any year bears no direct ratio to the quantity of lead concentrates smelted during that year. The reason for this is that the silver content is so small in quantity that the silver bullion is stored and refined in batches. If a series of years be taken into account, the concentrates are seen to average less than 1 ounce of silver to the ton.

The production of copper in Missouri in 1919 was 1,617,200 pounds, valued at $300,799, as compared with 577,665 pounds, valued at $142,683, in 1918. The North American mine, now owned by the Missouri Cobalt Co., which produced some copper as well as nickel and cobalt in the years 1908 and 1909, produced most of the copper in 1919. The remainder of the copper was derived from concentrates recovered in dressing lead ore mined in St. Francois County, in southeastern Missouri, and about 29,480 ounces of the silver reported from Missouri in 1919 was derived from copper concentrates and copper-nickel-cobalt ores.

LEAD AND ZINC.

The total value of the recoverable metallic content of the lead and zinc concentrates produced in Missouri in 1919 was $21,913,580, a decrease of $15,849,814 from that of 1918. The production of lead concentrates in Missouri in 1919 (of which all but 17 tons was galena) was 237,428 short tons, valued at $12,107,731, as compared with an output of 287,983 tons, valued at $21,988,567, in 1918, a decrease of 50,555 tons in quantity and of $9,880,836 in value. Of this production in 1919 of lead concentrates, 229,687 tons, valued at $11,590,977, was derived from southeastern and central Missouri, a decrease of 41,819 tons in quantity and of $8,916,087 in value. The average metal content of the lead concentrates from these districts was 68.4 per cent, as compared with 66.8 per cent in 1918, and the value per ton in 1919 was $50.46. The quantity of recoverable lead in southeastern and central Missouri concentrates in 1919 amounted to 157,158 tons, a decrease of 24,234 tons. The output was equal to about 37 per cent of the primary lead smelted or refined from domestic ores in the United States in 1919.

Shipments of galena concentrates from southwestern Missouri were 7,724 tons, valued at $516,148, as compared with 16,468 tons, valued at $1,480,910, in 1918. The lead carbonate concentrates amounted to 17 tons, valued at $606, an increase of 8 tons. The quantity of recoverable lead from southwestern Missouri, or the Joplin region, was 6,132 tons, valued at $649,992, a decrease of 6,651 tons. The average metal content of the galena concentrates from southwestern Missouri was 79.4 per cent, and the average selling price per ton was $66.82, or $23.09 less than in 1918.

The quantity of zinc blende concentrates sold from Missouri mines in 1919 was 51,813 tons, valued at $2,108,382, a decrease of 43,742 tons in quantity and of $2,790,965 in value, when compared with the figures for 1918. All the blende concentrate was produced in southwestern Missouri. The average price received per ton was $40.92, and the average recoverable zinc content reported by the sellers was 58.5 per cent. The average price received per ton in 1918 was $51.27 and the average recoverable zinc content was 58.2 per cent.

The zinc content of the sphalerite concentrates derived from "sheet ground" mines, which was 58.6 per cent in the years 1911 and 1912, declined to 58.3 per cent in 1913, increased to 58.4 per cent in 1914, to 59.1 per cent in 1915, and to 59.2 per cent in 1916, and decreased to 58.6 per cent in 1917, to 57.7 per cent in 1918, and to 54.9 per cent in 1919. The average price received for all sphalerite concentrates in 1919 was $10.35 a ton less than in 1918.

The zinc carbonate and silicate concentrates sold in 1919 amounted to 11,741 tons, valued at $320,853. This was 6,075 tons less in quantity and $253,283 less in value than the sales in 1918. The output in 1919 was mainly from southwestern Missouri, the shipments from southeastern and central Missouri being only 231 tons, valued at $6,576, as compared with 235 tons, valued at $6,845, in 1918. The average metal content of the zinc carbonate and silicate concentrates was 43.1 per cent in 1919. The average selling price per ton in 1919 was $27.33, as compared with $32.23 in 1918.

The combined value of lead and zinc concentrates from southeastern and central Missouri in 1919 (which produced about 97 per cent of the lead concentrates) was $11,597,553, or $8,916,641 less than in 1918.

The total value of the southwestern Missouri lead and zinc concentrates was $2,939,413, as compared with $6,947,856 in 1918, a decrease of $4,008,443.

The total quantity of crude ore or "dirt" mined and treated in 1919 amounted to 5,690,730 short tons, a decrease of about 3,456,070 tons, or approximately 38 per cent less than the quantity mined and treated in 1918. As the total amount received for all classes of lead and zinc concentrates sold in 1919 was $14,536,966, the average value per ton of crude ore or "dirt" mined and treated was $2.55, as compared with $3 in 1918, $3.04 in 1917, $2.60 in 1916, $2.20 in 1915, $1.65 in 1914, $1.72 in 1913, and $1.86 in 1912.

The cobalt-nickel-copper ore mined and shipped in 1919 is excluded from these calculations.

In the following tables showing the tenor of crude ore ("dirt") and concentrates from Missouri it has been considered advisable to segregate the ores of different nature. For instance, the disseminated lead ore of southeastern Missouri differs radically from the lead and zinc ores of the so-called "soft ground" deposits of southwestern Missouri, and these in turn differ from the "sheet ground" deposits of the same region. Each class of ore has its peculiar problems of mining and ore dressing. This fact makes desirable the separate treatment of the statistical data. In general, the tables reflect very closely the conditions of the industry.

Mine production of lead and zinc in Missouri in 1919.

District.	Lead concentrates.				Zinc concentrates.			
	Galena.		Carbonate.		Sphalerite.		Silicate and carbonate.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Southwestern Missouri:								
Alba-Neck City	.....	.....	.....	.....	258	$9,811	.....	.....
Aurora	15	$818	.....	.....	.....	.....	649	$17,105
Waco, (Mo.)	210	15,750	.....	.....	16,626	752,742	.....	.....
Carthage	7	429	.....	.....	4,045	172,886	.....	.....
Cave Springs, Zincite, and Klondike	16	1,035	.....	.....	459	19,300	.....	.....
Duenweg-Porto Rico	529	33,428	12	$402	2,540	111,151	3,183	94,314
Granby-Diamond	351	19,576	.....	.....	2,249	82,774	6,718	177,605
Joplin	923	59,259	.....	.....	10,597	432,850	853	22,591
Oronogo	1,640	106,184	.....	.....	7,909	280,153	.....	.....
Sarcoxie-Reeds	.....	.....	.....	.....	25	1,403	.....	.....
Spring City-Beef Branch	.....	.....	5	204	.....	.....	64	1,517
Springfield	304	21,793	.....	.....	650	30,024	.....	.....
Spurgeon-Seneca	67	3,758	.....	.....	127	4,902	8	145
Webb City-Carterville-Prosperity	3,642	252,718	.....	.....	5,871	194,483	.....	.....
Wentworth-Pierce City	.....	.....	.....	.....	377	12,821	.....	.....
Barry and Wright counties	20	1,400	.....	.....	80	3,082	35	1,000
	7,724	516,148	17	606	51,813	2,108,382	11,510	314,277
Central and southeastern Missouri	229,687	11,590,977	.....	.....	.....	.....	231	6,576
Statetotal,1919	237,411	12,107,125	17	606	51,813	2,108,382	11,741	320,853
1918	287,974	21,987,974	9	593	95,555	4,899,347	17,816	574,136

Mine production of lead and zinc in Missouri in 1919—Continued.

District.	Metal content.[a]			
	Lead.		Zinc.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Southwestern Missouri:				
Alba-Neck City			125	$18,250
Aurora	11	$1,166	231	33,726
Waco (Mo.)	172	18,232	9,243	1,349,478
Carthage	6	636	2,164	315,944
Cave Springs	12	1,272	245	35,770
Duenweg-Porto Rico	424	44,944	2,477	361,642
Granby-Diamond	273	28,938	3,500	511,000
Joplin	721	76,426	5,932	866,072
Oronogo	1,280	135,680	3,943	575,678
Sarcoxie-Reeds			13	1,898
Spring City-Beef Branch	2	212	22	3,212
Springfield	250	26,500	368	53,728
Spurgeon-Seneca	53	5,618	69	10,074
Webb City-Carterville-Prosperity	2,912	308,672	2,920	426,320
Wentworth-Pierce City			162	23,652
Barry and Wright counties	16	1,696	54	7,884
	6,132	649,992	31,468	4,594,328
Central and southeastern Missouri	157,158	16,658,748	72	10,512
State total, 1919	163,290	17,308,740	31,540	4,604,840
1918	194,175	27,572,850	55,992	10,190,544

[a] In calculating the metal content of the ores from assays allowance has been made for smelting losses in zinc but not in lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades and the value of the zinc from the average sales price of all grades reported by smelters.

Tenor of crude lead and zinc ore and concentrates produced in southwestern Missouri in 1917, 1918, and 1919.[a]

	1917	1918	1919
SOFT GROUND.			
Total crude ore.....short tons..	3,447,850	1,710,900	1,114,300
Total concentrates in crude ore:			
Lead.....per cent..	0.33	0.41	0.48
Zinc.....do....	3.71	4.30	5.24
Metal content of crude ore:			
Lead.....do....	.25	.32	.38
Zinc.....do....	1.99	2.30	2.90
Average lead content of galena concentrates.....do....	76.1	77.4	77.8
Average lead content of lead carbonate concentrates.....do....	62.2	55.5	53.0
Average zinc content of sphalerite concentrates.....do....	58.3	58.6	58.9
Average zinc content of silicates and carbonates.....do....	39.7	37.1	40.3
Average value per ton:			
Galena concentrates	$97.94	$87.35	$65.06
Lead carbonate concentrates	$76.36	$65.88	$35.65
Sphalerite concentrates	$69.50	$52.71	$41.33
Zinc silicates and carbonates	$40.50	$32.23	$27.33
SHEET GROUND.			
Total crude ore.....short tons..	7,688,250	1,903,300	274,500
Total concentrates in crude ore:			
Lead.....per cent..	0.36	0.51	1.01
Zinc.....do....	1.75	2.10	1.82
Metal content of crude ore:			
Lead.....do....	.28	.41	.82
Zinc.....do....	1.03	1.21	1.05
Average lead content of galena concentrates.....do....	75.9	77.4	81.1
Average zinc content of sphalerite concentrates.....do....	58.6	57.7	54.9
Average value per ton:			
Galena concentrates	$103.51	$91.32	$70.30
Sphalerite concentrates	$72.16	$49.25	$35.03

[a] Including also the small production of lead and zinc ores in southeastern and central Missouri, but exclusive of 57,000 tons of copper-nickel-cobalt ores from southeastern Missouri.

Tenor of crude lead ore and concentrates in southeastern Missouri disseminated lead ore in 1917, 1918, and 1919.

	1917	1918	1919
Total crude lead ore.....short tons..	5,887,900	5,532,600	4,301,930
Galena concentrates in crude ore.....per cent..	5.03	5.01	5.32
Lead content in crude ore.....do....	3.47	3.39	3.65
Average lead content of galena concentrates.....do....	66.7	66.8	68.4
Average value per ton of galena concentrates.....	$98.01	$75.53	$50.46

In Mineral Resources for 1914, Part I, pages 72–77 and 97–100, was given a brief history of lead and zinc mining in the southeastern Missouri and Joplin regions, together with data relating to the total lead and zinc production, the mining and milling practice, and the methods of selling ore and concentrates.

In order to expedite the publication and distribution of this report many of the data relating to individual properties as given in previous reports under the reviews by districts have been omitted. All the essential data relating to the districts are included in the yearly State review of the regions.

SOUTHWESTERN MISSOURI.

The southwestern Missouri lead and zinc areas include the largest part of the Joplin region, the remaining portion lying in southeastern Kansas and in northeastern Oklahoma. The Missouri part of the region was first developed, then that in Kansas, followed at a considerably later period by that in Oklahoma.

The ore in southwestern Missouri occurs in the Mississippian Boone limestone, in beds of Kinderhook age. The ore deposits are found in Jasper, Newton, Lawrence, Greene, and adjoining counties. This area produced in 1919 only 15.5 per cent of the crude lead and zinc ore mined in the Joplin region, compared with 34 per cent in 1918, 56 per cent in 1917, and 78 per cent in 1916.

The lead ores are galena, with a small quantity of lead carbonate, locally known as "dry bone." The zinc ores are sphalerite or zinc blende, or "jack," zinc carbonate (smithsonite), and zinc silicate (calamine), both of the latter locally called "silicate." The galena contains but a small fraction of an ounce of silver to the ton of lead concentrates, and although ordinarily it is not desilverized, yet occasionally the refineries find it advantageous to add lead from the Joplin region to their charges, without, however, making any record of the silver content. In this way an unknown but small quantity of silver is recovered from southwestern Missouri lead ore. The zinc ores, sphalerite, smithsonite, and calamine, contain notable quantities of cadmium, being fully as rich in this respect as the zinc ores of Silesia, which are the source of the cadmium produced in Europe. Discussion of the cadmium content of these ores is taken up in the chapters entitled "Cadmium," in Mineral Resources for 1908 and for 1917.

The ore deposits of the Joplin district vary in character with the depth of mining. The shallower ores beginning at the surface are

universally pockety and are found in residual clays or in "runs" in the basal breccias of the region. The breccias and the forms of the "runs" are largely, if not altogether, due to solution of the limestone strata. One form of run, which is fairly numerous, is the "circle" deposit, which, in the popular view, has come to be nearly synonymous with rich deposits. Small veins, vertical sheets, and thin crevice deposits are often met with in prospecting, but unless they develop into stringers leading into paying ore bodies are forgotten in the multitude of rich pockety deposits which the district has yielded. The blanket deposits or "sheet ground" are found in the Grand Falls chert member of the Boone limestone at depths ranging from 100 to 275 feet, according to the topography and the geologic structure. Below this horizon there are, in the beds of Kinderhook age, deposits of disseminated ore. They have been found in prospect shafts or drill holes near Springfield, Aurora, Granby, Carterville, Joplin, Hornet, and Cave Springs, in Missouri; at Galena, in Kansas; and at Quapaw, in Oklahoma.

Lead and zinc concentrates produced in the Missouri part of the Joplin region, 1907–1919.

	Quantity (short tons).	Value.
Lead concentrates	431,774	$27,187,709
Sphalerite concentrates	2,656,691	137,035,197
Zinc carbonate and silicate concentrates	278,780	8,638,897
	3,367,245	172,861,803

The average price per ton received for sphalerite concentrates during the period 1907 to 1919 was $51.58, that for zinc silicate and carbonate was $30.99, and that for lead $62.96.

Several of the assayers in the Joplin district make a practice of saving the remnants of blende samples analyzed during the year. At the close of the year the lot is thoroughly mixed and carefully sampled, from which sample an average or composite assay for the year is made. Each assay thus represents several thousand lots. Two representative series of such composite assays are given below. In most cases each sample included in the composite assay represents a carload lot of concentrates.

The first series, by W. W. Petraeus and Evans W. Buskett, of Joplin, gives the result of analyses of composite samples from the general district for the last 16 years. The analyses for 1897–1905, inclusive, were published in the Lead and Zinc News, volume 9, page 8, January 15, 1906. The analyses for 1906–1913 were kindly communicated by Mr. Petraeus, those for 1914–1917 by Mr. Buskett, and those for 1918 by W. P. Taylor, of Joplin, Mo. Iron was not taken into account until 1900. Some 400 scattering assays, made in 1895–1896, are excluded from the table.

Composite assays of zinc blende from the Joplin region, 1897–1919.

[W. W. Petraeus, analyst, 1897–1913; Evans W. Buskett, analyst, 1914–1917; P. W. Taylor, analyst, 1918.]

Year.	Number of lots in the composite.	Percentage.				
		Zinc.	Iron.	Lead.	Copper.	Cadmium.
1897	600	56.64				
1898	1,299	56.99				
1899	3,715	56.67				
1900	3,500	57.36	0.22			
1901	3,683	57.53	2.02			
1902	5,776	57.08	2.24			
1903	6,014	57.30	2.00			
1904	6,226	57.24	2.10			
1905	4,628	57.97	1.84	1.00	0.001	0.198
1906	5,644	57.2	2.00			
1907	6,813	56.8	1.93			
1908	7,873	56.4	1.76			
1909	9,002	56.3	2.00			
1910	8,892	56.6	2.10	1.02	.06	.399
1911	8,920	57.1	2.40			
1912	9,474	57.7	2.40			
1913	7,010	57.1	2.40			
1914	420	56.40	2.70			
1915	1,806	56.76	2.36			
1916	2,190	57.0	2.30	.54		
1917	3,000	57.3	2.25	.52		
1918	[a] 7,436	58.5	1.90	.98	.003	.221
1919 [b]						

[a] Lots of ore from many districts in Joplin region, including high-grade sphalerite.
[b] No average assay made, as samples from Missouri, Oklahoma, and Kansas were not kept separate.

A separate assay of 725 lots of high-grade sphalerite was also made in 1918 by W. P. Taylor, which showed 62.25 per cent zinc, 1.28 per cent iron, 0.111 lead, and 0.53 lime.

The next series of composite assays was communicated by Prof. W. George Waring and Bruce Williams, of Webb City. The original samples were of ores from the different camps of the district except where otherwise indicated. The methods used in making these assays have been published.[10]

[10] Waring, W. G., The volumetric determination of zinc: Am. Chem. Soc. Jour., vol. 26, No. 1, January, 1904. In addition to the composite assays for 1902 and 1903, shown in the table, the article gives the lead, copper, and cadmium content of a number of ores from individual mines in Missouri, Kentucky, and Illinois.

Composite assays of zinc blende from the Joplin region, 1900–1919.

[W. George Waring and Bruce Williams, analysts.]

Year.	Number of lots in the composite.	Percentage.				
		Zinc.	Iron.	Lead.	Cadmium.	Copper.
1900	3,894	57.30	3.03			
1901	5,172	56.00	3.30			
1901	2,577	55.30	3.85			
1901	[a] ±2,000	55.90	3.47			
1902	2,270	57.08	2.65	0.904	0.337	0.050
1903	2,145	57.75	2.32	1.072	.388	.049
1904	[a] 3,800	58.26	2.23	.701	.304	.049
1904	[b] 2,691	58.46	1.97	.720	.430	.050
1904	1,984	58.95	2.10			
1905	4,520	58.95	2.00			
1906	4,638	58.40	2.20			
1906	3,968	58.20	2.29			
1907–8	±4,000	58.70	2.00			
1909		[c] 57.40	2.60			
1910	6,377	[c] 57.90	2.60			
1911	5,653	58.20	2.35	.856	.450	.034
1912	6,709	56.72	2.50	1.070	.256	.022
1913	7,364	56.82	2.81	1.112	.209	.036
1914	7,981	56.56	2.80	1.30	.287	.038
1915	9,240	57.19	2.40	.985		
1916	10,451	57.95	2.20	.720	.262	.054
1917	10,041	58.10	2.65	.630	.324	.046
1918	[b] 8,255	57.35	2.60	.810		
1919 [d]						

[a] Joplin.
[b] Webb City.
[c] The composite sample included some lots of silicate ores.
[d] Composite sample was from a mixed lot of sphalerite derived from four States and is not comparable with samples for previous years.

The complete analysis of the composite sample of the 3,800 lots of concentrate from the Joplin region in 1904, sampled by C. V. Millar and analyzed by Waring, is as follows:

Analysis of composite samples of zinc blende from the Joplin region.

Zinc	58.26	Calcium carbonate	1.88
Cadmium	.304	Magnesium carbonate	.85
Lead	.70	Barium sulphate	.82
Iron	2.23	Silica	3.95
Manganese	.01		99.773
Copper	.049		
Sulphur	30.72		

Analysis of a representative sample of sphalerite jig concentrates from "sheet-ground ore" from the Carterville (Mo.) area.

[Waring & Williams Laboratories, Webb City, Mo., analyst.]

Zinc	59.20	Germanium, gallium, and indium (spectroscopic determination)	Traces.
Cadmium	.058	Calcium carbonate	Traces.
Lead	.293	Silica (possibly including traces of barium sulphate)	6.971
Iron	1.900		99.777
Copper	.054		
Sulphur	31.301		
Manganese			
Nickel and cobalt	Traces.		

The year 1919 was a disastrous one to all the operators of zinc mines in southwestern Missouri. Costs of mining and milling increased over those of 1918 and the selling price of both sphalerite and zinc silicate declined materially. Development in the "sheet-

ground" areas ceased entirely; no new mills were built, and many mills were torn down and moved. Some properties were operated the entire year, but these were a very small percentage of the total producers, for as the price for concentrates declined the number of operating plants decreased until at the end of 1919 the only mills treating ore from "sheet ground" were the Davey, at Carterville, and the Adams Hicks, at Joplin, which was shut down early in 1920. The only large mining operations in the Missouri part of the Joplin region were those at the Oronogo Mutual mine, at Oronogo; the Coahuila, at Carthage; the St. Regis, Little Bill, and C. M. & H., at Joplin; lessees of the American Zinc, Lead & Smelting Co., at Granby; and the Barnsdall, Gascho, Allegheny Western, High Five, Tulsa Pittsburgh, Freehold, and Gilman mines, in the Missouri part of the new Waco district. All these mines operate in "soft ground" and are making a much higher recovery of concentrates from crude ore mined than is usual in the district. Most of the miners found employment in the mines in the Miami and Waco districts, and the amount of prospecting done at outlying camps was not so great as in former years. The prospecting company at Webb City has drilled considerable territory and has made some leases to operators at low royalties, reinvesting the royalties in further prospecting.

The following quoted base prices apply not only to southwestern Missouri but also to all mines in Oklahoma and Kansas which are in the Joplin region. The average quoted base prices for 60 per cent sphalerite were highest during July, 1919, when $55 a ton was paid for part of the concentrates produced.

In the first week in January the base prices quoted were from $42.50 to $50 a ton. Base prices for the low grades declined to $40 in the first week of February, $43 in the last week of February, and $36 in the last week of April. In May base prices increased to $40 for low-grade concentrates and to $42 for high grade.

On the lower grades of sphalerite $50 to $55 was the prevailing price in July. It then declined to $42.50 in September, advanced to $45 early in October, and ranged between $45 and $47.50 until December, when it advanced to $50 and $51.

Base prices for calamine or zinc silicate ores followed the sphalerite quotations. The lowest base prices were quoted in May and June, when they ranged from $20 to $24 a ton, and the highest in December, when they ranged from $33 to $35 a ton.

The quoted price for galena carrying 80 per cent of lead showed wide variations, opening in January at $60 to $83 a ton and closing in December at $90 a ton. During the year galena sold for as much as $92 a ton in December and for as little as $50 at the end of February. The high prices did not stimulate the production of lead from southwestern Missouri, for there was a large decrease in production. There will be a further decrease in 1920, owing to the closing of all the mines that work "sheet ground."

The average price per ton paid for sphalerite or blende in 1919 was $40.67, as compared with $51.27 in 1918, $71.04 in 1917, $82.60 in 1916, $76.25 in 1915, $38.74 in 1914, $40.70 in 1913, and $50.44 in 1912; and for zinc silicate or carbonate concentrates it was $27.30 in 1919, $32.27 in 1918, $40.50 in 1917, $50.21 in 1916, $45 in 1915, $21.13 in 1914, $22.45 in 1913, and $28.95 in 1912. The average price paid for galena concentrates was $66.82 in 1919, as compared with $89.92

in 1918, $101.90 in 1917, $84.29 in 1916, $52.52 in 1915, $46.53 in 1914, $51.50 in 1913, $55.36 in 1912, and $55.75 in 1911. These prices are not averages of base-price quotations, but are the averages calculated from the quantity sold and the amounts received as reported to the United States Geological Survey by the sellers.

The prices received by the producers show that the average selling price of sphalerite in 1919 was $10.60 a ton less than in 1918, a decrease of 21 per cent, and that the corresponding decrease in prices for zinc carbonate and silicate in 1919 was $4.97, a decrease of 15 per cent.

The average metal content of sphalerite concentrates derived from "soft ground" increased from 58.6 per cent in 1918 to 58.9 per cent in 1919, and the content of those derived from "sheet ground" decreased from 57.7 per cent in 1918 to 54.9 per cent in 1919. The average metal content of the galena concentrates derived from "soft ground" was 0.4 per cent more than in 1918. The average metal content of the galena derived from "sheet ground" was 3.7 per cent more than in 1918.

The recovery of sphalerite and galena concentrates from "sheet ground" increased from 2.61 per cent in 1918 to 2.83 per cent in 1919, because nearly all the "sheet ground" mines averaging less than 2.50 per cent in concentrates were shut down early in 1918.

The average recovery of concentrates from "soft ground" increased from 4.71 per cent in 1918 to 5.72 per cent in 1919. This increase was due to the shutting down of a great many of the larger mines and the higher costs of mining.

The total ore or "dirt" treated decreased from 3,614,200 tons in 1918 to 1,388,800 tons in 1919. The "dirt" treated from "sheet ground" was 274,500 tons, a decrease of about 1,628,800 tons, and that from "soft ground" was 1,114,300 tons, a decrease of about 596,600 tons.

In 1919 the sphalerite concentrates derived from "sheet ground" mines amounted to 5,275 tons and the galena concentrates to 2,768 tons. In 1919 "soft ground" mines yielded 46,538 tons of sphalerite, 4,956 tons of galena, and all the lead carbonate, zinc silicate, and zinc carbonate concentrates. The production of sphalerite concentrates from "sheet ground" decreased 34,493 tons, and that of galena 7,005 tons. The decrease of sphalerite from "soft ground" was 9,236 tons, that of galena 1,739 tons, and that of zinc carbonate and silicate 6,071 tons.

The total value of all concentrates derived from "sheet ground" mines was $379,392, and from "soft ground" mines $2,560,021. This shows that the value of the production of concentrates from "soft ground" in 1919 amounted to $2,180,629 more than the production from "sheet ground," whereas it was $3,559,903 less in 1917. This radical change in the comparative value of the recovery made from the two classes of mining indicates plainly the disastrous effect of the increased cost of mining "sheet ground."

The Webb City-Carterville-Prosperity district, which includes most of the "sheet ground" mines, was again much the largest producer of galena concentrates in southwestern Missouri. It produced 47 per cent of the galena concentrates and 11 per cent of the sphalerite sold in 1919. The Waco district (in Missouri) produced 16,626 tons of sphalerite, which was a much larger output than that of any other

camp in Missouri, and it was the only camp that produced more sphalerite in 1919 than in 1918.

The production of the Joplin camp was about one-half as much as it was in 1918. The "sheet ground" mines were inactive or only operated for short periods. Very few new mines were developed, and those that were opened were operated on a small scale. Some of the large producers of sphalerite were the Little Bill Mining Co., St. Regis Mining & Smelting Co. (No. 2), C. M. & H. Mining Co., and lessees of the American Zinc, Lead & Smelting Co. and Rex Mining & Smelting Co.

The Duenweg-Porto Rico production of zinc and lead concentrates in 1919 was 529 tons of galena, 2,540 tons of sphalerite, and 3,183 tons of zinc silicate.

The Granby district produced 6,718 tons of zinc silicate and carbonate, which was 57 per cent of the total output of that class of zinc ore in Missouri in 1919. There were also shipments of 351 tons of galena and 2,249 tons of sphalerite, so that the value of the concentrates sold from that district was exceeded only by the value of the shipments from the Waco, Joplin, Webb City, and Oronogo camps.

At Oronogo the production of galena was 22 tons more and that of sphalerite was 470 tons more than in 1918.

There was very little mining in the Spring City and Thoms Station camps. About 304 tons of galena and 650 tons of high-grade sphalerite were shipped from the Big Ben and Lee mines, near Springfield.

The only shipments of ore from Barry and Wright counties were a few cars of galena and zinc silicate and carbonate.

CENTRAL AND SOUTHEASTERN MISSOURI.

The ore deposits of central and southeastern Missouri reach in a more or less connected belt from the region of Benton, Pettis, Morgan, Moniteau, Cole, and Miller counties on the northwest to the northern and eastern flanks of the St. Francis Mountains on the southeast. It is also true that there are scattered areas where more or less mining has been done all the way between the northwest end of this belt and the Joplin region, so that, strictly speaking, the lead and zinc deposits of Missouri practically form a zone around the northern half of the Ozark dome. A brief description of the ore deposits in central and southeastern Missouri is given in the separate chapter entitled "Silver, copper, lead, and zinc in the Central States in 1915," which may be obtained upon application to the Director, United States Geological Survey, Washington, D. C.

The ore in the southeastern Missouri region is almost wholly lead, although a considerable zinc deposit occurs at Valle mines, some 6 miles north of the Bonneterre district, and a considerable quantity of zinc silicate is mined in various parts of Washington and Jefferson counties. A certain percentage of zinc is also found in the disseminated lead ore, the ore from one shaft being reported to run occasionally as high as 2 per cent of zinc for a week at a time. The zinc occurs more plentifully in the Leadwood-Flat River district and may lie near the contact of the Bonneterre limestone with the Lamotte sandstone or some distance above it. In the lead concentrates zinc ranges from 1 to 5 per cent or more. In the maximum proportions

mentioned the zinc makes trouble in lead smelting, and for this reason some of the concentrating plants remove the zinc as a table middling.

Copper, nickel, and cobalt also occur in the ore, in considerable quantity in the vicinity of Fredericktown, and in small quantity, irregularly in nearly all the deep mines. It is only near Fredericktown that the copper, nickel, and cobalt content of the ore has been the object of mining, yet a concentrate of these metals has been recovered as a table middling at several plants in other parts of the district, and 3,115 tons of copper concentrates were shipped in 1915, 2,878 tons in 1916, 2,304 tons in 1917, and a much larger quantity in 1918 and 1919, as the Missouri Cobalt Co. shipped more low-grade concentrates.

In the disseminated ore district the production since 1869 increased rapidly and is estimated by Buckley to have amounted to 1,202,607 tons of lead concentrates, valued at $59,869,354, for the period between 1869 and 1906, inclusive. The mine production of southeastern and central Missouri has been reported to the United States Geological Survey since 1907.

Mine production of lead and zinc concentrates in southeastern and central Missouri, 1907–1919.

Year.	Lead concentrates—galena.		Zinc concentrates.			
			Sphalerite.		Carbonate and silicate.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1907	156,663	$7,910,398	100	$3,500	1,095	$15,330
1908	183,095	6,906,116	42	1,050	1,369	20,436
1909	210,620	8,823,297	41	938	1,284	17,334
1910	210,890	9,360,309	.....	.....	929	19,000
1911	219,145	10,293,400	113	3,990	510	11,576
1912	218,803	9,849,854	40	1,292	1,051	21,020
1913	219,511	9,580,893	33	574	639	13,491
1914	249,165	9,710,125	40	700	497	11,282
1915	278,104	12,773,579	43	1,064	1,061	39,460
1916	307,025	20,720,737	365	14,400	1,030	42,129
1917	306,473	30,070,995	186	16,344	293	7,145
1918	271,506	20,507,064	13	285	235	6,845
1919	229,687	11,590,977	.....	.....	231	6,576

A comparison of the estimates for the period of years to 1906 given by Winslow and Buckley for Washington and St. Francois counties (which have supplied a very large proportion of the galena ores from southeastern and central Missouri) with the figures in the preceding table indicates a production of galena concentrates during the last 13 years much greater than the entire output of southeastern and central Missouri prior to 1907.

The lead ore of southeastern Missouri carries a small proportion of silver, the average being less than 1 troy ounce to the ton of lead concentrates. The resulting pig lead likewise carries silver, together with a little copper, nickel, cobalt, and traces of antimony and arsenic, and is sometimes commercially known as "Missouri chemical" lead in contradistinction to "Missouri soft" lead from the Joplin region. An average of about 15 per cent of the total lead concen-

trates from southeastern Missouri is desilverized. The silver so recovered does not pay for the refining charges, but the desilverized lead commands a slightly higher price, making up the difference. As the silver content of the concentrates is so small, it is disregarded in their sale, and therefore the smelter reports are relied upon for the production of silver. As already explained, the quantity of silver produced during any year bears no direct ratio to the quantity of silver-bearing lead concentrates smelted during that year, for the reason that the silver bullion is stored and refined in batches at convenient times.

The output of silver in Missouri in 1919 was derived mainly from refining pig lead, the only other source of production being about 29,480 ounces recovered from cobalt-nickel-copper ores and from copper concentrates recovered in dressing lead ores, which were shipped to smelters.

The production of silver in southeastern Missouri was 90,401 fine ounces, valued at $101,249, as compared with 46,939 fine ounces in 1918, 61,586 fine ounces in 1917, 129,450 fine ounces in 1916, 57,756 fine ounces in 1915, 61,168 fine ounces in 1914, 35,620 fine ounces in 1913, 35,438 fine ounces in 1912, 49,867 fine ounces in 1911, 33,096 fine ounces in 1910, 14,188 fine ounces in 1909, and 49,131 fine ounces in 1908. The production of silver in 1919 was recovered from about 81,000 tons of lead concentrates and from copper concentrates that averaged slightly more than 1 ounce a ton.

The crude lead ore mined in the disseminated-lead district in 1919 amounted to 4,301,930 short tons, against 5,532,600 tons in 1918, 5,887,900 short tons in 1917, 5,467,500 short tons in 1916, 5,067,400 short tons in 1915, 4,718,300 short tons in 1914, 4,250,800 short tons in 1913, and 4,064,366 short tons in 1912. The crude ore in 1919 yielded 5.32 per cent of lead concentrates, which averaged 68.4 per cent of lead. The average value per ton of the lead concentrates in 1919 was $50.46, as compared with $75.53 in 1918, and the concentrates were slightly higher in lead content than in 1918. The output of galena concentrates was 228,983 tons, valued at $11,545,727, in 1919, against 271,153 tons, valued at $20,479,839, in 1918. As several of the large producers not only mine but also smelt their lead concentrates, the values given for concentrates are to a certain extent arbitrary. The galena concentrates produced in the southwestern Missouri region, which contain a higher lead content, are sold mainly on bids from purchasers, and the prices for those lead concentrates are not comparable with prices given for concentrates of the disseminated-lead district.

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Analyses of ores mined in disseminated lead district in southeastern Missouri and of the various grades of resulting concentrates.[a]

	Ag	Cu	Pb	SiO_2	Fe	Al_2O_3	CaO	MgO	Zn	S	Ni and Co
	Ozs. per short ton.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Ore (crude)	0.12	0.06	5.7	5.0	4.1	4.9	25.5	14.2	0.8	2.0	.....
High-grade concentrates	.7	.13	73.2	1.0	3.5	.....	2.6	.8	.4	15.0	0.05
Medium-grade concentrates	1.3	.12	68.6	1.4	4.6	.....	3.1	1.4	.8	15.5	.06
Low-grade concentrates	1.0	.30	65.8	.5	3.1	.5	4.3	2.8	1.7	13.7	.....
Flotation slimes, concentrates	.....	.50	45.0	9.6	4.4	3.1	7.5	4.2	4.0	12.3	.....
Flotation slimes, high-grade concentrates	3.7	.05	57.8	6.0	2.7	.....	2.2	1.4	9.4	15.5	.....
Joplin (southwestern Missouri) concentrates	.....	.....	80.2	1.1	1.0	.....	.4	.....	1.7	13.3	.....

[a] Garlichs, Herman, Metallurgy of lead ores in the lower Mississippi Valley: Am. Inst. Min. Eng. Bull., July, 1917, pp. 1041–1046.

NOTE.—A typical analysis of southeastern Missouri undesilverized lead is as follows: Ag, 0.0080 (2.4 oz. net short ton); As, trace; Sb, 0.0030; Bi, trace; Cu, 0.0800; Fe, 0.0015; Zn, trace; Ni and Co, 0.0080; lead by difference, 99.8995.

The production of zinc carbonate from southeastern Missouri in 1919 amounted to 231 tons, against 235 tons in 1918. All of the zinc carbonate was shipped from mines in Franklin County and in Jefferson County.

The quantity of galena recovered from shallow diggings in Washington and Jefferson counties was only about 420 tons. The high wages paid by the large mines in St. Francois and Madison counties attracted miners and laborers who normally lease and work many of the shallow diggings. The ore, which occurs at shallow depths and in association with barytes, is mined in a small way and at odd times by the barytes miners. This ore is all hand picked and cleaned, there being no concentrating plants. There are numerous other shallow lead and barytes diggings scattered over Washington County which are worked by small operators and farmers, who sell their product to the country merchants and to ore buyers. Much of this ore was purchased by J. F. Evans, of Potosi.

The production of galena concentrates from the disseminated-lead district showed another large decrease, the quantity decreasing about 42,170 tons and the value nearly $8,935,000. The quantity of crude ore treated decreased about 1,231,000 tons and the percentage of recovery in concentrates was a little more than in 1918.

The Buckeye or North American mine, at Fredericktown, was operated by the Missouri Cobalt Co. The concentrating plant, which has a capacity of 300 tons, and the 100-ton smelter were actively operated in 1919. A new refinery for the treatment of cobalt, nickel, and copper was also operated. The lead concentrates produced were smelted at the Federal plant, and the copper concentrates containing nickel and cobalt were shipped to the Grasselli Chemical Co., Grasselli, Ind., for making sulphuric acid. The cinders from the copper concentrates are returned to the smelter and refinery of the Missouri Cobalt Co. for the recovery of the cobalt, nickel, and copper. A considerable quantity of copper was sold in 1919 and some nickel and cobalt were marketed.

OKLAHOMA.

PRODUCTION.

Mine production of lead and zinc in Oklahoma in 1919.

District.	Ores.						Metal content.[a]			
	Lead concentrates (galena).		Zinc concentrates.				Lead.		Zinc.	
			Sphalerite.		Carbonate and silicate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Ottawa County:										
Miami	67,670	$4,592,870	336,403	$14,465,259	.....	.....	53,747	$5,697,182	178,069	$25,998,074
Quapaw	98	5,890	545	24,143	.....	.....	75	7,950	273	39,858
Peoria	62	4,760	123	5,160	20	$600	50	5,300	68	9,928
Total, 1919	67,830	4,603,520	337,071	14,494,562	20	600	53,872	5,710,432	178,410	26,047,860
1918	69,912	6,190,431	300,702	15,182,135	25	646	56,097	7,965,774	161,401	29,374,982

[a] In calculating the metal content of the ores for assays allowance has been made for smelting losses of zinc, but not of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades and that of the zinc from the average sales price of all grades reported by smelters.

The following table gives the output of crude lead and zinc ore for the whole State of Oklahoma, but it was thought advisable to calculate the tenor of crude ore and concentrates as well as assay content and value of concentrates separately for the Miami and Quapaw districts, inasmuch as the character of the ground operated in these districts has, until the new mines in the easterly extension of the Miami district, near Quapaw, were opened in 1918, differed so radically that general calculations for the State would be valueless:

Tenor of lead and zinc ore and concentrates produced in Oklahoma, 1917, 1918, and 1919.

	1917	1918	1919
Total crude ore milled in Oklahoma.....short tons..	3,523,200	5,754,700	6,168,200
Miami district:			
Total concentrates in crude ore—			
Lead.....per cent..	0.94	1.22	1.13
Zinc.....do....	4.56	5.23	5.47
Metal content of crude ore—			
Lead.....do....	.76	.98	.87
Zinc.....do....	2.72	3.13	3.21
Average lead content of galena concentrates.....do....	80.4	80.2	79.4
Average zinc content of sphalerite concentrates.....do....	59.6	59.6	58.8
Average value per ton—			
Galena concentrates.....	$100.77	$88.54	$67.87
Sphalerite concentrates.....	$67.44	$50.55	$43.00
Quapaw district:			
Total concentrates in crude ore—			
Lead.....per cent..	.51	.36	.57
Zinc.....do....	2.30	4.15	3.15
Metal content of crude ore—			
Lead.....do....	.41	.28	.43
Zinc.....do....	1.32	2.30	1.76
Average lead content of galena concentrates.....do....	78.8	78.7	77.0
Average zinc content of sphalerite concentrates.....do....	56.9	55.5	55.8
Average value per ton—			
Galena concentrates.....	$95.10	$92.27	$60.10
Sphalerite concentrates.....	$61.41	$41.19	$44.30

The chapter on the production of lead and zinc in Oklahoma in Mineral Resources for 1914 contains a brief history of mining in the various districts and also the estimated total production of each district, by years.

Mine production of lead and zinc concentrates in Oklahoma, 1891–1919.

District.	Lead concentrates (mainly galena).		Zinc concentrates.			
			Sphalerite.		Silicate and carbonate.	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Peoria	2,154	$105,158	220	$8,289	2,724	$72,970
Quapaw	4,096	263,344	34,087	1,473,145	164	2,692
Miami	227,406	17,508,231	971,547	49,109,638	.....	.....
Davis	.....	.....	558	27,399	899	24,592
	233,656	17,876,733	1,006,412	50,618,471	3,787	100,254

The total value of the lead and zinc concentrates produced in Oklahoma in 1919 was approximately 10 per cent less than in 1918 and followed increases of 52 per cent in 1918, 159 per cent in 1917, and 127 per cent in 1916.

The lead and zinc deposits of northeastern Oklahoma, so far as known, are confined to the limits of Ottawa County and form the southwestern extension of the Joplin region. There are three camps, Peoria, Quapaw, and Miami, in this county, in which extensive mining has been done, and a fourth, the Sycamore Creek district, along the Seneca fault block from 2 to 3 miles southwest of Seneca, Mo., in which considerable prospecting has been done and some ore mined.

The lead and zinc deposits in southern Oklahoma are near Ravia, at the southeast end of the Arbuckle Mountains, and near Davis, Murray County, at the northwest end of the same range.

The quantity of crude ore milled in Oklahoma increased from 5,754,700 tons in 1918 to 6,168,200 tons in 1919, notwithstanding the fact that the quantity of ore milled by the old mines near Commerce and at Quapaw was very much less in 1919 than in 1918.

The value of the recoverable lead and zinc produced at mines in Oklahoma in 1919 was $31,758,292, compared with $37,340,756 in 1918. The metal content of lead concentrates decreased from 56,097 tons, valued at $7,965,774, in 1918, to 53,872 tons, valued at $5,710,432, in 1919, and the recoverable zinc increased from 161,401 tons, valued at $29,374,982, to 178,410 tons, valued at $26,047,860.

In 1919 the lead concentrates produced in the Oklahoma districts were slightly lower in grade than those shipped in 1918. The average metal content of the sphalerite concentrates from Miami ore increased from 51.8 per cent in 1912 to 53.6 per cent in 1913, 54.8 per cent in 1914, 55.7 per cent in 1915, 55.77 per cent in 1916, 59.6 per cent in 1917 and 1918, and decreased to 58.8 per cent in 1919 and was 3 per cent more than the average metal content of the sphalerite from the Quapaw district in 1919.

The lead concentrates from Oklahoma sold in 1919 were 2,082 tons less in quantity and $1,586,911 less in value than in 1918. The Miami district (in Oklahoma only) produced about 75 per cent of the total production of lead concentrates in the Joplin region, exceeding the Joplin region in Missouri by about 59,900 tons. The Oklahoma shipments of sphalerite in 1919 amounted to 337,071 tons, valued at $14,494,562, an increase of 36,369 tons in quantity and a decrease of $687,573 in value. The shipments of zinc carbonate and silicate decreased from 25 tons in 1918 to 20 tons in 1919. The Miami district yielded about 99.8 per cent of the sphalerite concentrates and 99.7 per cent of the galena concentrates sold in Oklahoma in 1919.

Peoria district.—The production at Peoria, the oldest mining camp in the State, was only 62 tons of galena, 123 tons of sphalerite, and 20 tons of zinc silicate, all of which was mined by small operators at shallow levels.

Davis district.—No shipments of lead or zinc in 1919 were reported by any mines in the Davis district, in Murray County, southern Oklahoma.

Quapaw district.—The total production of concentrates was small in 1919, and none of the mills were in steady operation. The sales of galena decreased from 169 tons in 1918 to 98 tons in 1919, and those of sphalerite decreased from 1,953 tons in 1918 to 545 tons in 1919. The total value of the concentrates sold in 1919 was $30,033, a decrease of $65,931.

Miami district.—A history of the mining in this district, including the output by years for the period 1908 to 1914, and of the location of the mines and mills, was given in this report for the year 1914. The reports for the years 1915, 1916, 1917, and 1918 contain full reviews of the production, new territory prospected, new mines opened, and new mills erected in those years. Details of new mining plants and mills are omitted in this report on account of the unusual delay in publication.

A brief description of the ore deposits in the Miami district of Oklahoma is given in the separate chapter of Mineral Resources entitled "Zinc in 1915,"[11] which may be obtained on application to the Director, United States Geological Survey, Washington, D. C.

The mines of the Miami district in Oklahoma in 1919 shipped 67,670 short tons of galena concentrates, valued at $4,592,870, and 336,403 short tons of sphalerite concentrates, valued at $14,465,259, a decrease of 2,023 tons of galena concentrates and an increase of 37,654 tons of sphalerite concentrates when compared with the output of 1918. The average selling price of the galena concentrates decreased $20.67 a ton, and the average selling price of sphalerite concentrates, of which nearly five times as much was shipped, decreased $7.55 a ton. This increase in the quantity of concentrates shipped, followed an increase of nearly 200 per cent in 1917 and 92 per cent in 1918, does not adequately show the development during the last three years, for only a part of the milling plants were operated at capacity and many were idle most of 1919.

It is difficult to realize the possibilities of the output had there not been a shortage of labor and supplies and much lower prices of both galena and sphalerite.

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[11] Siebenthal, C. E., Zinc: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 888–890, 1917.

It was not advisable to force such rapid development, or rather production, in face of high operating costs and declining values. Many of the mines recovered large quantities of galena, which made operation profitable, notwithstanding the much lower selling price of sphalerite. The operating costs at Miami are greater than in most of the districts in the Joplin region and the royalties paid averaged 50 per cent more. The "dirt" or ore mined in 1919 averaged 0.88 per cent more in concentrates than that of all the "dirt" from "soft ground" treated in southwestern Missouri, and the average quantity of galena in the "dirt" at Miami was two and a half times as great. The increased recovery of concentrates in the Miami district and the larger quantity of galena recovered compensated for the higher operating costs, but it is certain that many of the Miami mines could not have profitably mined ore during 1919. Mining costs increased and it was difficult to ship concentrates owing to the shortage of cars. Some mines having rich ore were operated at a profit, but altogether 1919 was the most unprofitable year for more than 90 per cent of the mine owners.

All the mines are provided with shipping facilities by rail, and the construction of rock roads and permanent bridges for vehicles was continued, although hampered by the scarcity of labor.

The production in 1919 in the Miami district (in Oklahoma) was that of about 140 mills, of which 7 were in the old Commerce camp and the remainder in the territory north and northeast to the Kansas State line and east to Quapaw. Many of the mills were operated intermittently. It is estimated that in 1919 there were more than 200 concentrating plants—many of them of large capacity—built or under construction in Ottawa County.

The quantity of crude ore mined and milled increased from approximately 5,707,000 tons in 1918 to 6,149,300 tons in 1919. The percentage of concentrates recovered from crude ore milled was larger than in any other district in the Joplin region, and with increased operations in the northern part of the district the ore treated showed an increase in percentage of concentrates recovered from 5.5 per cent in 1917 to 6.45 per cent in 1918 and to 6.6 per cent in 1919. The average metal content of the sphalerite was 51.8 per cent in 1912 and 58.8 per cent in 1919, so that the total increase in the zinc content of the sphalerite sold has been 7 per cent in seven years.

The separate assays reported showed the zinc content to range from 48 to 63 per cent, but most of the blende assayed between 57 and 60 per cent. Assays of 965 lots of zinc concentrates in 1918 by Thor Relling, of Miami, showed an average content of 60.55 per cent of zinc, 0.75 per cent of lead, and 1.1 per cent of iron, and the average content of 198 lots of galena concentrates assayed was 79.15 per cent of lead. An assay of a composite sample taken from 8,485 car samples of ore shipped in 1919 from the Miami-Blue Mound region made by Bruce Williams, of Joplin, Mo., showed an average zinc content of 59.2 per cent and about 1.75 per cent of iron. The average selling price of galena concentrates decreased from $88.54 in 1918 to $67.87 in 1919, and that of sphalerite concentrates decreased from $50.55 in 1918 to $43 in 1919.

The recovery of galena concentrates from all the mines averaged about 1 to 4.8 tons of sphalerite, which is a much higher average than

in any other district in the Joplin region. The proportion of galena concentrates recovered from the "dirt" mined showed wide variations, ranging in different mines from less than 1 ton of galena to 100 tons of sphalerite to 1 ton of galena to 1 ton of sphalerite. The mines lying north and northeast of the Quapaw mine near Commerce reported 66,946 tons of galena and 334,981 tons of sphalerite; those lying southwest of the Quapaw mine to the southern limits of the district reported 724 tons of galena and 1,422 tons of sphalerite. None of the mines in the Horse Shoe Lake area, immediately north of Miami, reported any shipments in 1919.

Those mines situated in the new camps in the vicinity of Tar River, Picher, Douthat, St. Louis, and Hockerville treated about 6,096,200 tons of crude ore, which yielded 66,946 tons of galena concentrates and 334,981 tons of sphalerite, an average recovery of 1.1 per cent in galena concentrates and 5.49 per cent in sphalerite concentrates and a total recovery of 6.59 per cent. As some of the large mines reported a recovery as high as 8 to 15 per cent, many of the mines must have treated ore that yielded only 3 to 4 per cent, or even less, in concentrates. It is difficult to segregate the producing mines according to camps. The production in 1919 came from the vicinity of Picher, Tar Creek, and Douthat (Century), and near St. Louis (now Zincville), and Hockerville.

The total shipments of those properties that may properly be classed as in the Tar River-Douthat area, of which there were a greater number than in the other areas, were 29,626 tons of galena and 152,809 tons of sphalerite. About 3,010,000 tons of "dirt" was milled, so that the recovery in concentrate averaged about 6.06 per cent. A few of the mines yielded nearly as much galena as sphalerite; in a few mines the proportion of galena was as little as 1 per cent, and the proportion of galena to sphalerite on the whole was less than that recovered from the mines near Picher. The proportion of galena to sphalerite recovered at all the mines in the vicinity of Douthat was about 1 ton of galena to 8 of sphalerite; in the Tar River section the mines yielded about 1 ton of galena to 4.2 tons of sphalerite.

The territory lying east of Picher, near the Hockerville and Zincville (St. Louis) camps, was one of the most actively developed areas in the Miami district. In 1918 the shipments from 14 mines were 1,438 tons of galena and 29,646 tons of sphalerite, which was recovered from approximately 348,000 tons of crude ore. In 1919 the shipments from 18 mines were 6,291 tons of galena and 52,870 tons of sphalerite. The sphalerite averaged about 59.2 per cent of zinc content and the output of galena was proportionately less than in other parts of the Miami district.

The production of the mines in the vicinity of Picher showed an increase in 1919. In 1918 the quantity of ore milled was 2,118,900 tons and 33,200 tons of galena, and 101,949 tons of sphalerite were shipped. In 1919 the quantity of ore milled was 2,373,100 tons and 31,029 tons of galena, and 129,302 tons of sphalerite were shipped, which indicates a recovery of approximately 6.76 per cent in concentrates, of which one-fourth was galena.

WISCONSIN.

PRODUCTION.

Mine production of lead and zinc in Wisconsin in 1919.

District.	Ores.						Metal content.[a]			
	Lead concentrates.		Zinc concentrates.				Lead.		Zinc.	
	Galena.		Sphalerite.		Silicate and carbonate.					
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
Benton-New Diggings.	3,337	$206,506	83,482	$1,982,903	.....	.....	2,486	$263,516	25,620	$3,740,520
Cuba City	1,366	89,570	6,810	102,104	.....	.....	1,036	109,816	1,474	215,204
Dodgeville	20	1,500	145	3,511	80	$1,800	15	1,590	61	8,906
Hazel Green	70	4,432	9,701	230,948	.....	.....	47	4,982	2,684	391,864
Highland	178	13,713	464	10,012	5,700	109,065	134	14,204	1,765	257,690
Linden	49	3,534	1,030	24,959	.....	.....	37	3,922	853	124,538
Livingston and Mifflin.	288	18,118	23,157	314,102	.....	.....	208	22,048	4,501	657,146
Mineral Point Montfort	1	40	.....	.....	53	993	1	106	12	1,752
Platteville and Potosi.	.....	.....	1,937	80,877	.....	.....	.....	.....	1,013	147,898
Shullsburg	337	22,382	7,523	190,864	.....	.....	250	26,500	2,782	406,172
Total, 1919	5,646	359,795	134,249	2,940,280	5,833	111,858	4,214	446,684	40,765	5,951,690
1918	6,210	501,901	175,339	4,507,638	5,215	117,630	4,533	643,686	50,014	9,102,548

[a] In calculating the metal content of the ores for assays allowance has been made for smelting losses in the case of zinc but not in the case of lead. In comparing the values of ore and metal it should be borne in mind that the value given for the ore is that actually received by the producer, whereas the value of the lead is calculated from the average sales price of all grades and that of the zinc from the average sales price of all grades reported by smelters.

Tenor of lead and zinc ore and concentrates produced in Wisconsin, 1918 and 1919.

	1918	1919
Total crude ore ..... short tons	2,377,300	1,826,200
Total concentrates in crude ore:		
Lead ..... per cent	0.26	0.31
Zinc ..... do	7.60	7.67
Metal content in crude ore:		
Lead ..... do	.19	.24
Zinc ..... do	2.61	2.71
Average lead content of galena concentrates ..... do	73.0	74.6
Average zinc content of sphalerite concentrates ..... do	34.6	35.3
Average zinc content of zinc carbonate concentrates ..... do	27.7	34.6
Average value per ton:		
Galena concentrates	$80.82	$63.73
Sphalerite concentrates	$25.70	$21.90
Zinc carbonate concentrates	$22.56	$19.18

The lead and zinc mines of Wisconsin are in Grant, Iowa, and Lafayette counties and comprise the most important part of the ore deposits of the upper Mississippi Valley region, a historical review of which is given in the Illinois section of this report in Mineral Resources for 1914. A detailed description of the Wisconsin lead

and zinc districts and of the mines in each district to the year 1906 is given by Bain.[12]

Although mining development has continued and many new mines have been opened, worked out, and abandoned, the area of the mining region has not been enlarged to any extent. The development of the mines subsequent to Bain's report and the output of Wisconsin mines have been given in the reports in Mineral Resources of the United States for the years 1907 to 1918.

The ore deposits occur in the Galena dolomite and in the upper part of the Platteville limestone, both of Ordovician age. The ores are galena, sphalerite or zinc blende, with smithsonite or zinc carbonate, the last locally known as "dry bone." As a lead region the district has been known from the earliest settlement days. In time the building of smelters near by made a market for the zinc ores. The first zinc ore to be mined was the carbonate found in association with lead in the shallow working above ground-water level. When all the main deposits were worked out down to water level there was a lull in mining in the region. Though the carbonate was known to give place to zinc blende and the lead to continue on below water, it was not deemed profitable to mine when continued pumping was necessary. About 1900 the higher price of zinc led to the opening of some of the deposits below water level, since which time zinc mining has increased until Wisconsin ranks among the largest of the zinc-producing States. The ore bodies are found in perpendicular, horizontal, or inclined cavities known as "openings" or "crevices," "flats," and "pitches." The openings sometimes extend for a considerable distance in a straight line called a "range," and may be mined at different places by different companies. When a range is once established it becomes an important guide in prospecting.

The galena of the district is nonargentiferous, and so far as known the zinc ores are free from cadmium. In some of the mines marcasite is so plentiful that the zinc blende concentrates are reduced to a very low grade. Owing to their nearness in specific gravity, marcasite and blende are very difficult to separate cleanly by hydraulic methods.

Roasting and electromagnetic separation have been utilized in the district for many years—and especially in the last five years—to produce a marketable zinc product. The green sulphide concentrates are roasted in cylindrical roasters to drive off a little sulphur and render the iron sulphide magnetic, after which they are treated on electromagnetic separators and yield blende concentrates assaying from 56 to more than 60 per cent and pyrites tailings, which are purchased by manufacturers of sulphuric acid. Comparatively few of the concentrating plants are equipped with roasters, but practically all the larger mining interests own or control separating plants.[13]

The roasting and separating plants operated in Wisconsin in 1919 were those of the Mineral Point Zinc Co., at Mineral Point; the Champion plant of the Wisconsin Zinc Co., at New Diggings; the National Zinc Separating Co. and the Linden Zinc Co., at Cuba City; the Blockhouse Mining Co., at Platteville; and the Oliver Iron Mining Co., at Shullsburg.

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[12] Bain, H. F., Zinc and lead deposits of the upper Mississippi Valley: U. S. Geol. Survey Bull. 294, pp. 81–148, 1906.

[13] Deutman, E. G., The roasting and magnetic separation of Wisconsin zinc ores: Eng. and Min. Jour., June 28, 1919, pp. 1107–1111.

Approximately 165,000 tons of sphalerite concentrates were shipped in 1919 from mines in the upper Mississippi Valley region, and of this quantity about 143,000 tons was treated at roasting and separating plants in Wisconsin. More than 80 per cent of the raw concentrates were treated at three plants controlled by interests affiliated with the largest producers in the region—the Mineral Point Zinc Co., Wisconsin Zinc Co., and Vinegar Hill Zinc Co.

The average zinc content of the raw sphalerite concentrates sold in 1919 was 35.3 per cent and the average selling price per ton was $21.90; the corresponding content and price for 1913 were 38 per cent and $21.53; for 1914, 35.05 per cent and $17.73; for 1915, 36.5 per cent and $38.37; for 1916, 34.4 per cent and $36.75; for 1917, 32.8 per cent and $29.48; and for 1918, 34.6 per cent and $25.70.

The percentage of concentrates recovered from crude ore is much higher than in the Joplin region, but the zinc concentrates average 21 to 25 per cent less in zinc content. On account of these conditions, at many mines no close recovery is made and the tailings can seldom be profitably reworked. The new concentrating plants, however, are equipped with more tables than formerly. The concentrates from the tables have a very high iron content, but this can be remedied by roasting.

The crude ore yields from 5 to more than 20 per cent of concentrates. The average recovery in concentrates increased from 7.86 per cent in 1918 to 7.98 per cent in 1919, which was a natural reflection of the lower price of sphalerite concentrates. The mining methods are largely determined by the mode of occurrence of the ores, but otherwise are similar to those in vogue in working the pockety ores at Joplin. The milling methods used in the Wisconsin field have been given by Walter Schultz,[14] of the Wisconsin Zinc Co.

The zinc-carbonate ore, which is mined principally in the Highland, Benton, and Mineral Point districts, is purchased mainly by the Mineral Point Zinc Co. and made into zinc oxide in the plant at Mineral Point, Wis.

The metal content of the raw sphalerite concentrates sold by the mines varied in 1918 from 16.08 to 51 per cent. The larger portion of the concentrates sold ranged between 28 and 38 per cent. The zinc content of the roasted sphalerite concentrates shipped varied from 57 to 61 per cent.

The value of the mine output of lead and zinc in Wisconsin for the year 1919 was $6,398,374, against $9,746,234 in 1918, a decrease of $3,347,860.

The lead concentrates sold decreased from 6,210 tons, valued at $501,901, in 1918, to 5,646 tons, valued at $359,795, in 1919. The sphalerite concentrates sold decreased from 175,339 tons to 134,249 tons, and their value decreased from $4,507,638 to $2,940,280.

The quantity of zinc-carbonate concentrates shipped increased from 5,215 tons in 1918 to 5,833 tons in 1919, and the value decreased from $117,630 to $111,858.

The metal content of the lead concentrates in 1919 was 319 tons less than in 1918. The recoverable zinc content of the sphalerite and zinc-carbonate concentrates in 1919 decreased 9,249 tons.

[14] Schultz, Walter, Milling Wisconsin lead-zinc ores: Eng. and Min. Jour., July 14, 1917, pp. 82–84.

Forty-four milling plants were in operation during 1919, but many of these plants were idle at the end of the year. Very little development work was done in 1919, and very few new mines were opened. As in all other mining regions during 1919, labor was scarce, and costs of mining and milling increased to such an extent that many of the small operators suspended work.

The larger mining interests in the Wisconsin field, which include the Mineral Point Zinc Co., Wisconsin Zinc Co., Vinegar Hill Zinc Co., Frontier Mining Co., had a combined output approximately equal to 65 per cent of all the lead concentrates and 78 per cent of all the zinc concentrates shipped from Wisconsin mines in 1919. Mines controlled by the Laurence Mines Co., Blockhouse Mining Co., Connecting Link Mining Co., Rodham McQuitty Mining Co., Zinc Hill Mining Co., and the Oliver Iron Mining Co. contributed substantially to the output in 1919.

For descriptions of the old mines and concentrating plants on which no essential changes were made during 1919, the reader is referred to the corresponding section of this report in Mineral Resources for 1914, 1915, 1916, 1917, and 1918.

The Benton-New Diggings district produced about 59 per cent of the galena and more than 62 per cent of the sphalerite shipped from Wisconsin in 1919. Its output was about four times that of Livingston, the next largest producing district. The districts in Wisconsin that had a larger production of zinc concentrates in 1919 than in 1918 were Cuba City and Hazel Green. The quantity of ore treated was about 551,100 tons less in 1919 than in 1918, and the quantity of green sphalerite concentrates recovered was about 23 per cent less than in 1918.

The shipments from the Benton part of the Benton-New Diggings district in 1919 were 835 tons of galena and 17,061 tons of sphalerite, a decrease of about 43 per cent. The shipments from New Diggings camp were 2,502 tons of galena and 66,421 tons of sphalerite.

The Hoskins mine of the Mineral Point Zinc Co., located at New Diggings, which was opened in 1917, was the largest producer in Wisconsin of both galena and sphalerite in 1919, and the Champion mine of the Wisconsin Zinc Co. had the second largest output of sphalerite. The other large producing properties at Benton-New Diggings in 1919 were the Longhorn and C. A. Thompson mines of the Wisconsin Zinc Co., the Meloy and Martin mines of the Vinegar Hill Zinc Co., the Penna-Benton of the Mineral Point Zinc Co., the Indian Mound of the Laurence Mines Co., the Bearcat, Middi, and Robson mines of the Frontier Mining Co.

Most of the production in the Cuba City district in 1919 was that of the Connecting Link Mining Co., and of the Big Dick and Little Dick mines of the Zinc Hill Mining Co.

The producing mines in the Hazel Green district were the Kennedy, Monmouth, and Jefferson.

The only large shippers in the Highland district were the Highland and the Lampe mines. Only one milling plant was operated by the Mineral Point Zinc Co.

The shipment of sphalerite from the Livingston and Mifflin districts in 1919 was 23,157 tons, 9,442 tons less than in 1918. The only

large producing mines were Coker No. 1 and Coker No. 2 of the Mineral Point Zinc Co., and the Yewdall mine and Dale Rundell mines of the Vinegar Hill Zinc Co.

There was very little mining near Mineral Point in 1919, and the only concentrates shipped were purchased from scrappers.

Mines in the Platteville and Potosi districts produced 1,937 tons of sphalerite in 1919, nearly all of which was shipped by the Blockhouse Mining Co.

The production of both galena and sphalerite from mines in the Shullsburg district in 1919 was less than in 1918. Nearly all the shipments were those of the Oliver Iron Mining Co., Rodham McQuitty Mining Co., and Wisconsin Zinc Co. (Copeland mine).

UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS ON GOLD, SILVER, COPPER, LEAD, AND ZINC IN THE CENTRAL STATES.[15]

ADAMS, G. I., Zinc and lead deposits of northern Arkansas: Bull. 213, pp. 187–196, 1903. 25 cents.

ADAMS, G. I., and others, Zinc and lead deposits of northern Arkansas: Prof. Paper 24, 118 pp., 1904. 40 cents.

BAIN, H. F., Lead and zinc deposits of Illinois: Bull. 225, pp. 202–207, 1904. 35 cents.

——— Lead and zinc resources of the United States: Bull. 260, pp. 251–273, 1905. 40 cents.

——— Zinc and lead ores in 1905: Mineral Resources U. S. for 1905, pp. 379–392, 1906. $1.

——— Zinc and lead deposits of northwestern Illinois: Bull. 246, pp. 56, 1905. 15 cents.

——— Zinc and lead deposits of the upper Mississippi Valley: Bull. 294, 155 pp., 1906. 75 cents.

——— Reported gold deposits of the Wichita Mountains, Okla.: Bull. 225, pp. 120–122, 1904. 35 cents.

BAIN, H. F., VAN HISE, C. R., and ADAMS, G. I., Preliminary report on the lead and zinc deposits of the Ozark region: Twenty-second Ann. Rept., pt. 2, pp. 23–228, 1902. $2.25.

BAIN, H. F., and ULRICH, E. O., The copper deposits of Missouri: Bull. 260, pp. 233–235, 1905. 40 cents.

BUTLER, B. S., and SIEBENTHAL, C. E., Silver, copper, lead, and zinc in the Central States in 1909 (mine production): Mineral Resources U. S. for 1909, pt. 1, pp. 495–531, 1911. 60 cents.

BUTLER, B. S., and DUNLOP, J. P., Silver, copper, lead, and zinc in the Central States in 1910 (mine production): Mineral Resources U. S. for 1910, pt. 1, pp. 611–674, 1911. 75 cents.

——— Idem for 1911, pp. 793–872, 1912. 90 cents.

——— Idem for 1912, pp. 437–521, 1913. 90 cents.

——— Idem for 1913, pp. 81–171, 1914. 70 cents.

——— Idem for 1914, pp. 27–124, 1915. 75 cents.

CLERC, F. L., The mining and metallurgy of lead and zinc in the United States: Mineral Resources U. S. for 1882, pp. 358–386, 1883. 50 cents.

DUNLOP, J. P., and BUTLER, B. S., Silver, copper, lead, and zinc in the Central States in 1915 (mines report): Mineral Reseources U. S. for 1915, pt. 1, pp. 45–137, 1917. See also Butler, B. S., and Dunlop, J. P.

——— Idem for 1916, pp. 53–157, 1917.

——— Idem for 1917, pp. 73–130, 1921.

——— Idem for 1918, pp. 59–125, 1921.

ELLIS, E. E., Zinc and lead mines near Dodgeville, Wis.: Bull. 260, pp. 311–315, 1905. 40 cents.

[15] The publications for which a price is given are no longer available for free distribution but can be purchased from the Superintendent of Documents, Washington, D. C.; others can be obtained free on application to the Director of the United States Geological Survey. Some are out of print but may be examined in libraries.

GRANT, U. S., Zinc and lead deposits of southwestern Wisconsin: Bull 260, pp. 304–310, 1905. 40 cents.

GRANT, U. S., and BURCHARD, E. F., Geol. Atlas, Lancaster-Mineral Point folio (No. 145), 1907. 5 cents.

IRVING, R. D., The copper-bearing rocks of Lake Superior: Mon. 5, 464 pp., 1883. $1.85.

LINDGREN, WALDEMAR, Resources of the United States in gold, silver, copper, lead, and zinc: Bull. 394, pp. 114–156, 1909. 40 cents.

——— Tests for gold and silver in shales from western Kansas: Bull. 202, 21 pp., 1902. 5 cents.

SIEBENTHAL, C. E., Mineral resources of northeastern Oklahoma: Bull. 340, pp. 187–228, 1908. 30 cents.

——— Origin of the zinc and lead deposits of the Joplin region, Missouri, Kansas, and Oklahoma: Bull. 606, 283 pp., 11 pls., 1915. 25 cents.

SMITH, W. S. T., Lead and zinc deposits of the Joplin district, Missouri-Kansas: Bull. 213, pp. 197–204, 1903. 25 cents.

SMITH, W. S. T., and SIEBENTHAL, C. E., Geol. Atlas, Joplin district folio (No. 148), 1907. 50 cents. Apply to Geological Survey.

ULRICH, E. O., and SMITH, W. S. T., Lead, zinc, and fluorspar deposits of western Kentucky: Bull. 213, pp. 205–213 (25 cents), 1903; Prof. Paper 36, 218 pp., 1905. 40 cents.

VAN HISE, C. R., and LEITH, C. K., The geology of the Lake Superior region: Mon. 52, 1911. $2.50.

WINSLOW, ARTHUR, The disseminated lead ores of southeastern Missouri: Bull. 132, 31 pp., 1896. 5 cents.

ANTIMONY.

By Frank C. Schrader.

THE ANTIMONY SITUATION.

The United States is dependent upon three classes of material as sources of antimony or its alloys or compounds. (1) Antimony ore is imported from China (direct or via Japan), Bolivia (via Chile and Peru), and Mexico, and small quantities of ore are at times produced in the western United States. (2) Liquated antimony sulphide, also known as "crude antimony," "needle antimony," and antimony matte, is imported in small quantity from China. This material is produced by submitting the ores of the natural antimony sulphide, stibnite, to a heat sufficient to melt but not to decompose it, and the molten metallic sulphide is then run into molds and allowed to cool. (3) Metallic antimony, known as antimony regulus, is imported from China, Japan, and Mexico and during the war was produced in small quantity in the United States from both foreign and domestic ores. The metallic antimony imported from Japan is derived mainly from the refining of Chinese ore or "crude." A fourth class of material which should also be mentioned is antimonial lead, carrying from 12 to 18 per cent of antimony. Any of the three classes of materials noted above may enter into this product, but it is derived mainly from lead ores, most of them of the antimonial variety.

The United States has always been dependent mainly on foreign sources for its supplies of antimony. China and Japan have been the principal contributors, although Mexico and Bolivia have also made considerable contributions. This dependence is in part a reflection of the higher wage scale in this country as compared with certain foreign countries, particularly China, but it is due also to our comparative poverty in antimony resources. However, little information of a quantitative nature has been collected concerning these resources, and they may be somewhat greater than has generally been assumed.

As there was no domestic production in 1919, the reader is referred to the report for 1918 for the latest descriptive statement on that phase of the subject. The examination in 1919 of a few of the deposits in Lander County, Nev., indicates the presence of moderate reserves of ore at those localities.

The antimony market is widely recognized as one of the most unstable of the metal markets. The world requirements of antimony are comparatively small, and when an extra quantity is thrown upon the market prices react sharply and production rapidly falls off.

[1] Much of the material relating to trade conditions in the United States during the World War and data relating to foreign countries are derived from the chapter on antimony in 1918, by Henry G. Ferguson, in Mineral Resources, 1918, pt. 1, pp. 33-57, 1919.

For many years prior to the World War the New York prices of the ordinary grades of metallic antimony ranged from 6 to 8 cents a pound. The average yearly quoted price from 1909 to 1913, inclusive, did not fall below 7.27 cents; the highest price during the period, 7.63 cents, was established in 1912; and the lowest average monthly level during the same period, 6.05 cents, was established in December, 1913.[2]

The imports, calculated as antimony metal, formerly ranged from about 4,000 to 7,500 short tons; and the production from ores mined in this country was negligible. With the outbreak of the World War the price of antimony began to rise rapidly because of the need of the metal in the manufacture of shrapnel bullets, and as uncertainty was felt as to the continuance of supplies from abroad, numerous mines in the Western States and several in Alaska were put into operation. By the end of 1915 the New York price had reached 40 cents a pound, and by March, 1916, it attained its maximum, for ordinary grades, of about 44 cents. These high prices drew out in the United States in 1915 a production of ore carrying about 2,100 short tons of antimony, and in 1916 ore containing about 1,770 short tons of antimony. The high prices also greatly stimulated imports, as is shown in Plate I, and this forced down the prices of ordinary grades to 11 or 12 cents a pound late in 1916 and made it impossible for most of the new domestic mines to operate at a profit. By the end of 1916 many of these mines had closed and others were in a precarious condition.

In anticipation of the entrance of the United States into the war there was a notable recovery in prices, ordinary grades reaching about 33 cents in April, 1917. This increase again stimulated imports (see Pl. I), which proved to be far in excess of the demands and not only forced a rapid decline in price to a fairly constant level of about 14 cents during the last half of 1917, but also built up large stocks in bonded warehouses (see fig. 5) and in the hands of dealers and consumers. Stocks in bonded warehouses alone, which were negligible in the early part of 1917, amounted to more than 10,000,000 pounds at the end of the year. The decline in prices in 1917 dealt a heavy blow to domestic antimony mining, which during the year produced ore carrying only about 390 short tons of metallic antimony. Before the end of the year nearly all domestic mines had ceased operation.

In 1918 the prices of antimony did not show the extreme fluctuations of the three preceding years. As the large stocks on hand at the beginning of the year were absorbed, imports increased. In January the price was slightly above 14 cents a pound; this decreased gradually to about 12 cents in May and then rose to 14 cents a pound in September. As antimony was used in large quantities for war purposes, the declaration of the armistice brought a sharp drop in price. For the week ending October 26 the average price quoted by the Engineering and Mining Journal was 13 to 13½ cents a pound. The following week prices fell off about 1 cent. On November 9 the price quoted was 10 to 11 cents, and on November 16, 9 cents. Prices fell to about 7 cents a pound at the end of the year, and stocks in bonded warehouses amounted to about 5,000,000 pounds, or about half what they were at the beginning of the year.

[2] Metal Industry, December, 1920.

Domestic production could not make a profit at the prices prevailing in 1918 and only about 190 tons of ore, containing about 50 tons of antimony, was mined. The mines practically ceased operations early in 1918 and remained idle during 1919. The antimony smelters continued production from imported ores until November, 1918, when all production of metallic antimony was temporarily suspended. Two smelters made a small output from foreign and domestic ores in 1919, but the Geological Survey is not at liberty to disclose the figures reported.

The sudden ending of hostilities found all the Allies holding large stocks of antimony, more than sufficient for a year's supply. In addition to these stocks there were large supplies of antimonial lead and other alloys available, and more was obtained by salvage. As the metallic antimony available in this country at the beginning of 1918 equaled a normal year's domestic consumption and there was made available during that year from all sources 24,636 tons, the total supply of metallic antimony available at the beginning of the year 1919 must have exceeded a normal year's domestic consumption.

Moreover, at the beginning of 1919 the antimony market was confronted with 5,056,368 pounds of antimony held by the United States Government in bonded warehouses pending liquidation, and the offer for sale by the Canadian Government of 3,000,000 pounds of the metal, together with large quantities of antimonial lead containing 2,400,000 pounds of antimony.[3] These sources alone amounted to more than 5,200 tons, which, together with large stocks in the hands of dealers and manufacturers of antimony alloys and type metal, probably also exceeded a year's domestic consumption. Notwithstanding this large surplus at the beginning of the year, there was imported during the year nearly 15,000,000 pounds, or 7,500 tons, of antimony, considerably more than an additional half year's consumption, with the result that prices continued to be forced downward. Presumably also the stocks of shrapnel on hand in the different countries are sufficient as a reserve stock for possible future wars, should any occur before a substitute for antimony in shrapnel may be discovered.

These unabsorbed supplies, the continuation of imports, and the increased cost of mining further discouraged production, with the result that the average quoted price of antimony in 1919 was almost as low as in 1913.

In 1919 the average quoted price of antimony was about 8.2 cents a pound. The prices continued low, but as shown in Plate I they were free from war-time fluctuations and more steady than for any of the preceding four years. They were confined to the limits of 6⅞ cents and 9¼ cents, a total range of only 3⅜ cents. The price compares favorably with the price of 7.52 cents in 1913 and, together with the growing steadiness in the market, it seems to indicate that the antimony trade is approaching normal.

In January, 1919, the markets everywhere were reported to be overstocked. The average price for the month was approximately 7½ cents, only about half of what it was in the same month of 1918. The lowest price for the year, 6⅞ cents, was reached late in March and the highest price, 9¼ cents, late in December.

[3] Mineral Industry, 1919.

During the year the Government's large war surplus stock was absorbed, and at the end of the year the stock left throughout the country was low. Stocks in bonded warehouse amounted to 2,404,904 pounds, or about half of what they were at the beginning of the year.

Most of the producers of antimony ore report that a price of 20 to 25 cents a pound for metal would be required to make the mining of domestic antimony ore profitable at the costs prevailing in 1918. It is probable, however, that antimony mining could be undertaken if there was assurance that a price of 16 or 17 cents would be continued over a considerable period.

As there seems to be a surplus of antimony ores for the entire world, there is no reason to expect that prices of antimony will increase during 1921 unless there should be a greatly increased tariff imposed on antimony and antimony ores or new uses of considerable extent for antimony should be found. Other than the import duty of 10 per cent on antimony metal and 15 per cent on type metal, there are no restrictions on imports of antimony.

USES.

The peace uses of antimony are many, but only a few require large quantities of the metal, and although its war-time production, as shown in figure 2, amounted to nearly 82,000 metric tons a year, it yet remained a minor metal. Its field of uses, however, exclusive of the abnormal war demand, seems to be gradually widening. Consumption of the metal in 1919 is believed to have been somewhat larger than in pre-war years.

Metallic antimony unalloyed has few industrial uses. In the form of fine powder, known as "iron black," it is used for producing the appearance of polished steel on articles made of papier-mâché or pottery. For these purposes it is precipitated by the action of metallic zinc on an acid solution of antimony salts. Antimony alloys readily with most heavy metals, and the alloy is harder than the two pure metals. Most of these alloys possess the property of slight expansion on solidifying. Type metal is an alloy of antimony, lead, and tin; babbitt, antifriction, or bearing metal is usually an alloy of antimony, tin, and copper. Britannia metal, also known as "white metal," is an alloy of antimony, tin, and copper, with some zinc, and rarely, small quantities of other metals. It is used in making cheap domestic tableware, teapots, and spoons. Antimony alloys find minor utilization in battery plates, toys, cable coverings, and siphon tops. Small quantities of antimony enter into certain brasses and aluminum alloys. Lead-antimony alloy, or "hard lead," is used in making acid-resisting valves.

White antimony oxide, mainly the tetraoxide (Sb_2O_4), is used for making opaque white enamel and other sanitary ware. In this use antimony oxides compete with tin oxide. Antimony oxide, mainly trioxide, is used as a coloring agent in the manufacture of glass, as it is more readily fusible than tetraoxide and does not impart opacity to the glass. Antimony oxides are also used as paint pigments.

The red sulphides of antimony are used in vulcanizing and coloring red rubber and also as paint pigments. The natural antimony trisulphide, stibnite, enters into the composition of safety matches or of the compound which is put on the match box.

"Sugar of antimony" (powdered oxide?) is used in making furniture polish, and the chloride ($SbCl_3$) is used in the preparation of fireproof preservatives of wood, paper, and textile fabrics, such as creosote, pitch, tar, and asphalt.

Antimonate of lead, containing an excess of lead oxide, known as "Naples yellow," is used in oil paints and in the glass and ceramic industries. Tartar emetic (double tartrate of antimony and potassium) and antimony fluoride are employed as mordants in dyeing. Tartar emetic and antimony trioxide are employed medicinally.

Antimonial lead carrying 12 to 13 per cent of antimony is employed in the manufacture of bullets. Antimony sulphide is almost universally used as a constituent of primers in shells and cartridges.

Antimony sulphide as a powder is used in the charges of some shells to produce on explosion a dense white smoke, which is of service in range finding.

DOMESTIC PRODUCTION.

Antimony ore produced in the United States, 1915–1919, in short tons.

Year.	Ore.	Metal content.
1915	5,000	2,100
1916	4,500	1,770
1917	1,060	390
1918	190	50
1919	0	0

Metallic antimony produced at smelters in the United States, 1917–1919, in short tons.

Year.	From domestic ores.	From foreign ores.
1917	258	2,182
1918	127	2,490
1919	(a)	(a)

[a] A small quantity was produced by two smelters, but the Survey is not at liberty to publish the figures.

Besides the small quantity of metallic antimony, there was also produced from foreign and domestic ores a relatively large quantity of oxides and other salts, the figures for which the Survey is not at liberty to publish.

SMELTER PRODUCTION OF ANTIMONIAL LEAD.

The production of antimonial lead from lead skimmings as a by-product of the lead-smelting industry is tabulated for recent years in the chapter dealing with lead from figures collected by C. E. Siebenthal, of the United States Geological Survey.

By-product antimonial lead produced in the United States from both foreign and domestic ores, 1916–1919.

Year.	Quantity (short tons).	Antimony content (short tons).	Value of antimony content.[a]
1916	24,038	3,496	$1,775,968
1917	18,646	2,759	1,142,226
1918	18,570	2,566	646,632
1919	13,874	1,943	318,652

[a] Calculated on basis of average yearly price of 25.4 cents a pound, or $508 a short ton, in 1916; of 20.7 cents a pound, or $414 a short ton, in 1917; of 12.6 cents a pound, or $252 a short ton, in 1918; and of 8.2 cents a pound, or $164 a short ton, in 1919, for ordinary grades in the New York market.

A newly recognized possible source of antimony on a small scale is its recovery as a by-product from smelter flue dust. The dust of one plant is reported to contain from 1 to 2 per cent of antimony.

RECOVERY OF SECONDARY ANTIMONY.

During 1919, 4,399 short tons of antimony was recovered from old alloys, scrap, and dross. Practically all of this was recovered in the forms of alloys, not as metallic antimony.

Antimony content of secondary alloys recovered from old alloys, scrap, and dross, 1913–1919.

Year.	Quantity (short tons).	Value. [a]
1913	2,705	$401,963
1914	2,646	444,844
1915	3,102	1,811,568
1916	4,480	2,270,016
1917	4,961	2,061,700
1918	5,226	1,317,000
1919	4,399	717,900

[a] Values calculated at average yearly price for ordinary brands of antimony.

IMPORTS.

The accompanying statistics of imports are compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, long tons being recalculated to short tons. The imports are reported as (1) imports for consumption, including merchandise entered for immediate consumption or withdrawn from bonded warehouses for consumption, and (2) total or general imports. Only total imports are listed by countries of origin.

Antimony imported and entered for consumption in the United States, 1913–1919.

Year.	Antimony ore. [a]			Liquated antimony sulphide. [b]		Metallic antimony. [c]		Antimony oxides and other compounds. [d]	
	Quantity (short tons).	Antimony content (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1913	2,860	2,007	$137,361	3	$419	6,240	$798,581	984	$117,169
1914	1,791	1,254	71,341	49	4,004	6,555	736,420	1,372	315,001
1915	2,494	1,544	332,125	.....	.....	7,354	2,660,830	423	132,193
1916	7,840	4,622	1,072,340	.....	.....	7,064	3,548,507	243	109,832
1917	10,083	5,832	1,006,884	796	128,660	11,286	2,829,159	10	5,368
1918	3,363	1,425	177,731	833	113,258	14,011	3,065,619	18	11,904
1919	993	409	54,477	278	19,202	7,159	1,021,587	126	9,501

[a] Classified in tariff classification as "Antimony ore and stibnite containing antimony."
[b] Classified in tariff classification as "Antimony matte, containing not more than 10 per cent of lead."
[c] Classified in tariff classification as "Antimony regulus or metal."
[d] Classified in tariff classification as "Antimony, oxide, salts, and compounds of."

For years large quantities of antimonial lead were imported into the United States as type metal, for which it is largely used, but from 1912 to 1918 these imports declined. In 1919, however, they increased to 6,697 tons. They came mostly from Canada and probably

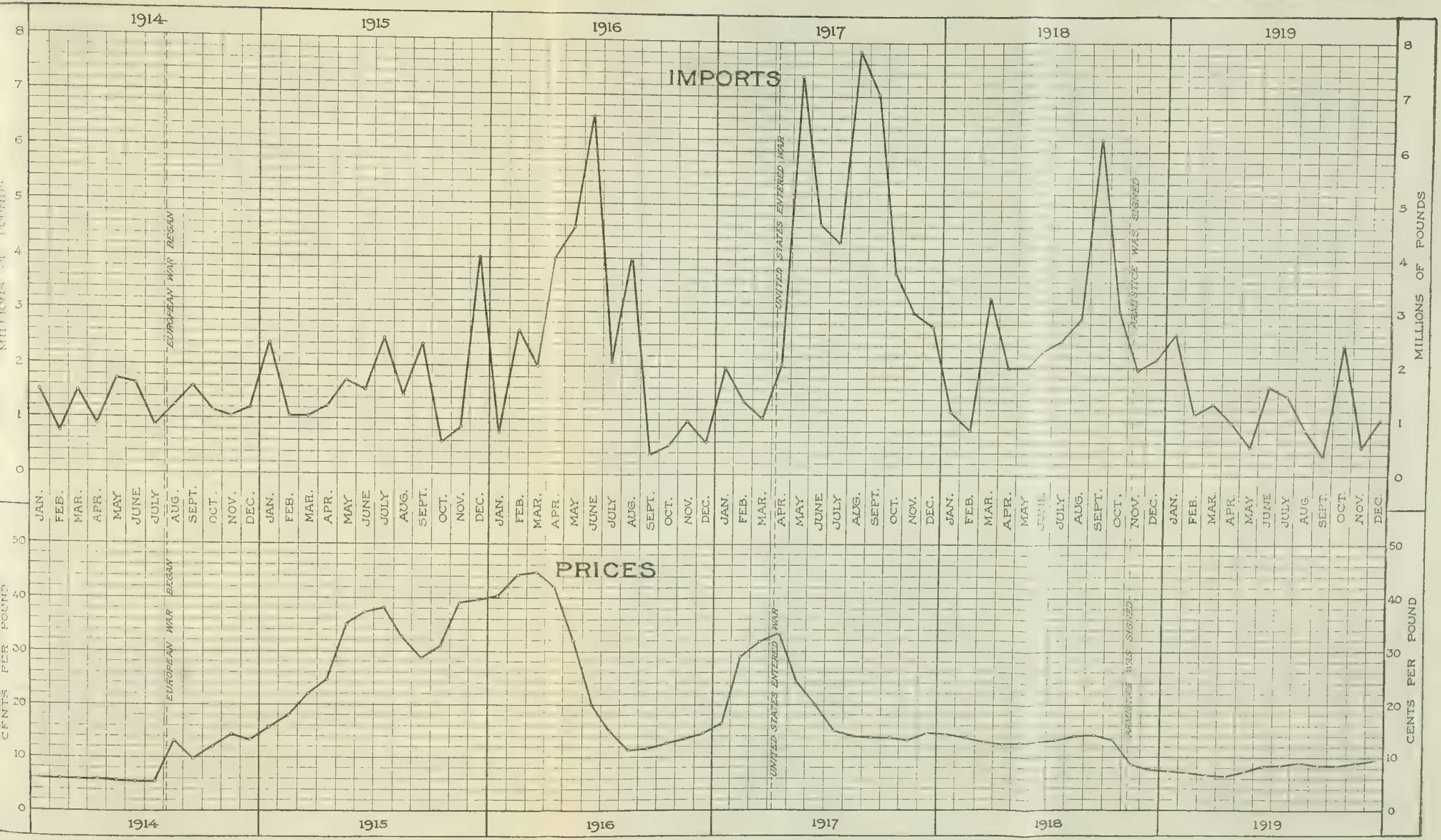


DIAGRAM SHOWING IMPORTS OF ANTIMONY AND AVERAGE PRICES OF ORDINARY GRADES OF ANTIMONY METAL IN NEW YORK MARKET, BY MONTHS, 1914 TO 1919

consisted largely of shrapnel lead, which contains about the same per cent of antimony as type metal.

Total imports [a] of antimony into the United States in 1917–1919.

Country.	Antimony ore.			Antimony metal. [b]	
	Quantity (short tons).	Antimony content.		Quantity (pounds).	Value.
		Quantity (pounds).	Value.		
1917.					
Canada	126	105,077	$15,762	190,000	$24,879
Newfoundland and Labrador	22	30,136	1,985	.....	.....
Mexico	2,116	1,434,403	76,712	4,126,659	416,866
Argentina [c]	596	632,662	55,514	.....	.....
Chile [c]	4,098	5,131,569	507,463	.....	.....
Peru	44	27,570	3,636	.....	.....
Colombia	2	2,356	255	.....	.....
Honduras	3	4,785	1,563	.....	.....
China [d]	2,949	4,060,353	331,504	11,324,846	1,333,541
Hongkong [d]	.....	.....	.....	859,835	101,568
Japan [d]	.....	.....	.....	18,677,597	2,333,745
England	.....	.....	.....	470,176	87,081
Portugal	302	390,282	27,870	.....	.....
Portuguese Africa [e]	112	101,250	9,734	.....	.....
	10,370	11,920,443	1,031,998	35,649,113	4,297,680
1918.					
Canada	.....	.....	.....	231,990	22,856
Panama	1	711	128	.....	.....
Mexico	1,623	1,203,257	80,540	5,958,689	560,872
Chile [c]	987	1,343,700	84,890	.....	.....
Peru	11	14,594	1,100	.....	.....
China [d]	112	156,800	9,480	14,271,511	1,354,360
Hongkong [d]	.....	.....	.....	1,064,224	109,532
Japan [d]	.....	.....	.....	6,221,904	616,643
	2,734	2,719,062	176,138	27,748,318	2,664,263
1919.					
England	.....	.....	.....	90,048	8,803
Canada	.....	.....	.....	2,308,880	167,764
Panama	2	1,200	99	.....	.....
Mexico	297	219,048	11,332	757,076	60,571
Newfoundland	.....	28	10	.....	.....
Chile [c]	47	49,624	6,312	.....	.....
Peru	74	90,726	7,345	.....	.....
China [d]	455	362,326	23,936	7,847,840	459,613
British India	.....	.....	.....	224,000	10,976
Hongkong [d]	4	4,510	493	68,320	3,949
Japan [d]	.....	.....	.....	2,953,994	159,091
	879	727,462	49,527	14,250,158	870,767

[a] Includes large quantities of antimony metal that went into bonded warehouse and that are not included in the table of imports for consumption.

[b] Includes small quantities of liquated antimony sulphide, known in the trade as "crude antimony," "antimony matte," or "needle antimony."

[c] Imports credited to Chile originated mainly in Bolivia; those credited to Argentina may also be from Bolivia.

[d] Nearly all the imports of antimony ore and metal from Hongkong and Japan are of Chinese origin. Some of the material credited to other countries is possibly also of Chinese origin, having been transshipped in a foreign port.

[e] Probably of Transvaal origin.

The total or general imports showed a decrease of about 50 per cent in quantity and 67 per cent in value in 1919, as compared with 1918. Imports of ore decreased to less than a third of the imports for 1918. China and Mexico were the only important sources of foreign ore. Imports of metal decreased nearly 50 per cent, owing largely to decreased shipments from Mexico and China. Imports of ore from China more than quadrupled and those of metal decreased nearly 45 per cent. As shown in Plate I, imports reached their maximum of

2,600,000 pounds in January and their minimum of 400,000 pounds in September. Their most marked increase was from 400,000 pounds in September to 2,400,000 pounds in October and their sharpest decrease was from 2,400,000 pounds in October to less than 600,000 pounds in November. They showed a similar though less marked decrease from January to February. They closed the year at the 1,000,000-pound mark in December, with a strong upward tendency.

Type metal imported and entered for consumption, 1911–1919.

Year.	Type metal.		Assumed antimony content.	
	Quantity (short tons).	Value.	Quantity (short tons).	Percentage.
1911	4,195	$310,658	727	17.3
1912	291	18,668	52	17.9
1913	284	20,098	50	17.6
1914	755	45,373	94	12.4
1915	1,384	107,607	172	12.4
1916	581	83,816	119	20.5
1917	None.		None.	
1918	276	35,938	19	6.9
1919	6,697	816,642	1,197	17.9

The customs returns give only the lead content of imported type metal, and the figures given above are based on the assumption that the remainder is practically all antimony, but this assumption is arbitrary, for imported type metal contains as much as 2 per cent of impurities, such as iron, arsenic, and copper. The antimony content is therefore probably too large by some quantity less than or approximately equal to 2 per cent of the total quantity of type metal, and the correct percentage is correspondingly lower.

EXPORTS.

Foreign antimony exported from the United States, 1914–1919.[a]

Year.	Ore.			Matte, regulus, or metal.	
	Quantity (short tons).	Antimony content (pounds).	Value.	Quantity (pounds).	Value.
1914				1,600,979	$211,742
1915		195	$8	3,146,135	786,766
1916	231	255,695	9,874	3,018,251	761,045
1917				989,477	169,260
1918				1,410,970	164,666
1919	3	5,380	1,665	429,059	33,913

[a] Exports go mainly to Canada.

STOCKS.

The metallic antimony in bond December 31, 1918, as reported by the bureau of Foreign and Domestic Commerce, was 5,000,000 pounds. During January, 1919, the stocks were increased to 6,726,464 pounds, of which quantity more than an average was maintained until the end of April. Stocks then declined rapidly to

4,120,992 pounds by the end of May. The average of this quantity was approximately maintained until the end of August, after which there was a sharp decline to 3,125,874 pounds by the end of September, a slight increase during October, a sharp decline to 2,475,061 pounds by the end of November, and a further slight decline during December, so that at the end of the year stocks in bonded warehouse were approximately 2,400,000 pounds, or about 1,200 short tons. The stocks of antimony held by dealers and manufacturers are not known, but the Government stocks were all sold out during the year. It is noteworthy that, exclusive of stocks in bond, the antimony available for consumption during 1919 decreased to about three-fifths of the quantity available in 1918, the figures being approximately 15,000 tons in 1919 and 25,000 tons in 1918. The decrease was due chiefly to the falling off in imports and to a shrinkage of antimonial lead and other alloy sources of the metal.

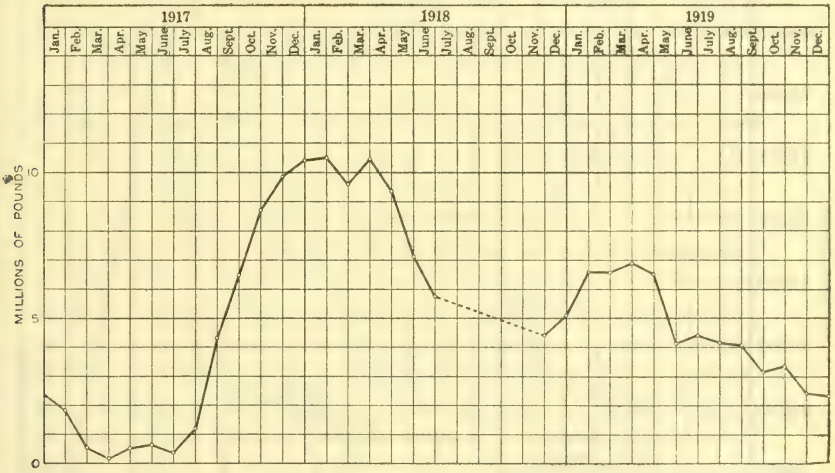


FIGURE 5.—Diagram showing stocks of metallic antimony in bonded warehouse at end of each month in 1917, 1918, and 1919, as reported by the Bureau of Foreign and Domestic Commerce.

PRICES.

The average New York quotations for the ordinary grades of metallic antimony for the last 25 years, in cents per pound, are given by the Engineering and Mining Journal as follows:

1895	7.56	1904	6.37	1913	7.52
1896	6.65	1905	10.25	1914	8.76
1897	6.75	1906	21.73	1915	30.28
1898	8.69	1907	14.84	1916	25.37
1899	9.43	1908	8.00	1917	20.69
1900	9.50	1909	7.47	1918	12.58
1901	8.25	1910	7.39	1919	8.19
1902	6.12	1911	7.54		
1903	6.00	1912	7.76		

The fluctuations in average monthly prices for the ordinary grades of metallic antimony during the six years 1914 to 1919 are shown diagrammatically in Plate I.

WORLD'S PRODUCTION.

The distribution of the principal antimony deposits of the world is shown on Plate II.

As the United States is almost completely dependent on foreign sources for its supply of antimony, a rather detailed review of conditions affecting production in foreign countries is given in the following pages. The accompanying diagram gives the world's production of antimony in terms of estimated recoverable content of the ore produced. The figures are only approximately accurate, as reliable statistics are not available for two of the largest producers, China and Mexico. For these countries it has been necessary to use the export figures for metal plus an estimate for the recoverable antimony in the ore and crude exported.

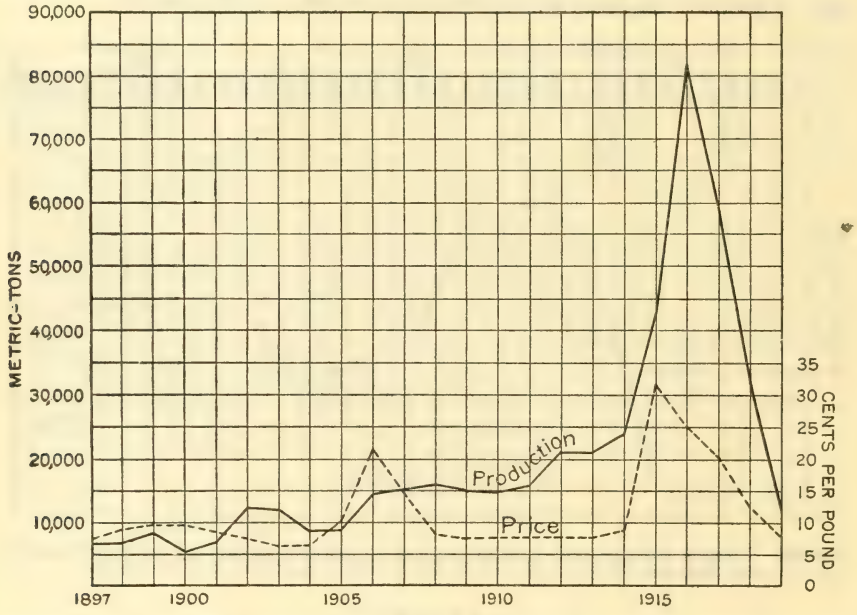
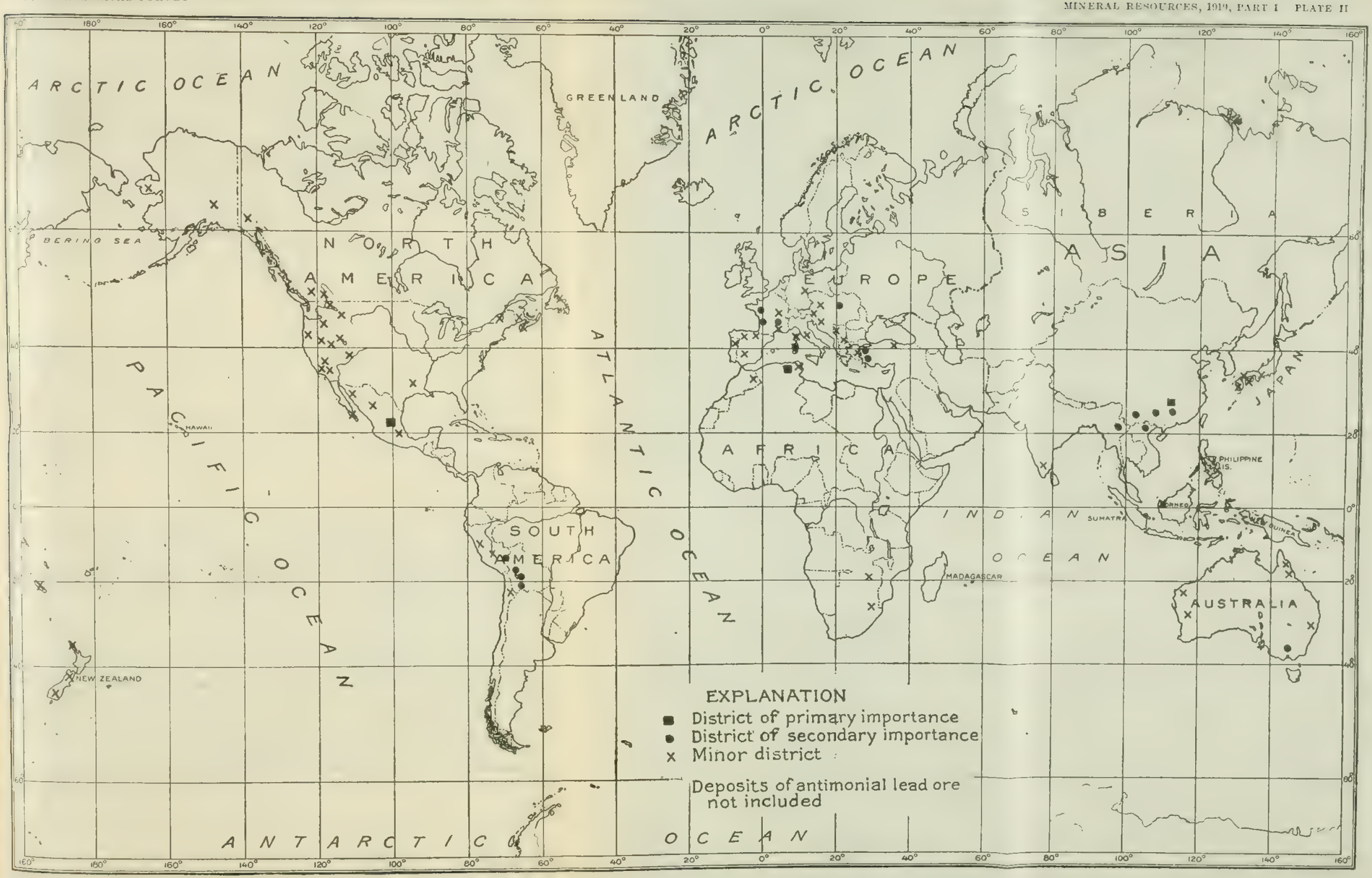


FIGURE 6.—Diagram showing world's production of antimony, based on estimated recoverable content of antimony ore, and average price per pound in New York.

From 1897 to 1902 the world's antimony production averaged about 7,000 metric tons a year. The demand caused by the Russo-Japanese war caused a temporary increase in production. The sharp rise in price in 1905 and 1906, caused apparently by speculation and based in part on the fear that the Chinese deposits were becoming exhausted, brought the annual production up to about 15,000 tons. This rate continued after the fall in price in 1907 and 1908 and was maintained until about 1912, when there was an increase, due principally to increased production in China, to more than 24,000 metric tons. The rise in prices in the second half of 1914, consequent on the war demand, caused a tremendous increase in production, which reached its maximum in an estimated world production of nearly 82,000 tons in 1916. The demand for war



MAP SHOWING LOCATION OF PRINCIPAL ANTIMONY DEPOSITS IN THE WORLD.

uses had then been met, and the falling prices in 1916 and 1917 were reflected in the decreased production in 1917.

Because of the various and not strictly comparable terms in which production is reported in most foreign countries, it is impossible to give more than a rough comparison between the principal important producers. As nearly as can be estimated the production of antimony ore in 1913, the last year for which even approximately complete statistics are available, amounted to about 24,500 metric tons of recoverable antimony, exclusive of the antimony content of antimonial lead ores. The consumption is even more difficult to estimate, as customs figures for different countries are widely at variance. The relative importance of the principal producing and consuming countries in terms of percentages of the world's normal output for 1913 is about as follows:

Percentages of the world's production and consumption of antimony in 1913, by countries.

Country.	Percentage of production.	Percentage of consumption.
Austria-Hungary	8	4
France	21	20
Germany	.....	20
Italy	1	2
United Kingdom	.....	12
Serbia	1	.....
Asia Minor	1	.....
Japan	.....	10
China	53	
Algeria	1	.....
United States	.....	32
Mexico	10	.....
Australia (Victoria)	4	Small.
	100	100

The following table shows the world's production for the years 1912–1919 so far as reasonably approximate data are available. As the data for 1919 from many foreign countries are not yet available, the total production here given for that year is probably much too small. An attempt has been made to reduce all statistics of production to a common basis—that of the recoverable metal content of the ore produced. The totals do not imply that this quantity of metallic antimony was actually produced. A part of the ore goes directly into the manufacture of oxides and other salts, and in recent years lead smelters have purchased antimony ore which is smelted with lead ore for the direct production of antimonial lead. On the other hand, a small quantity of antimony is produced by lead refineries, and the antimony content of antimonial lead ores is not included in the table because sufficient data are not available.

It is evident that the world's present capacity to produce antimony far exceeds the normal demand.

World's production of antimony, 1912–1919, in metric tons.

[Approximate recoverable metal content of ore produced; antimonial lead ores not included.]

Country.	1912	1913	1914	1915	1916	1917	1918	1919
United States				1,760	1,420	310	45	
Canada				381	272	87	7	1
Mexico	3,500	2,340	1,570	a 200	829	2,647	3,269	62
Bolivia	40	30	102	9,859	15,077	12,860	4,770	(b)
Peru				260	930	450	160	3
Hungary	872	1,038	(b)	(b)	(b)	444	(b)	(b)
Austria-Hungary	1,160	840	(b)	(b)	(b)	(b)	(b)	(b)
Germany			(b)	a 700	(b)	(b)	(b)	(b)
France	1,910	5,170	540	893	2,430	2,354	1,329	97
Italy	310	360	138	720	4,334	960	(b)	(b)
Spain	170			100	170	160	a 20	
Portugal	50	10	(b)	(b)	a 1,000	(b)	(b)	(b)
Serbia	300	a 250	(b)	(b)	(b)	725	(b)	(b)
Algeria	1,417	186	320	2,740	8,940	4,550	2,218	60
British South Africa		30		50	380	300	99	2
China	13,530	13,032	19,647	23,357	42,800	31,000	a 18,112	8,92
Japan	75	20	32	180	280	8	41	(b)
India					400	50		a 7
Indo-China				160	642	101	(b)	(b)
Borneo			300	120	(b)	(b)	(b)	(b)
Asia Minor	270	240	(b)	(b)	(b)	(b)	(b)	(b)
Victoria	590	960	890	1,300	1,320	(b)	576	580
New South Wales	40	10	20	320	310	150	a 120	a 30
Queensland				80	80	(b)	(b)	3
Western Australia					20	10	(b)	20
	24,234	24,516	23,559	43,180	81,634	57,166	30,766	11,839

a Incomplete data; actual production probably larger.
b No data.

FOREIGN DEPOSITS.

NORTH AMERICA.

CANADA.[4]

Production of antimony ore in Canada has been extremely irregular. During periods of high prices a considerable output has been obtained; the years of maximum production were 1898 and 1907, when shipments of 1,344 short tons and 2,016 short tons, respectively, were made. Mining ceased in 1910 and was not resumed until 1915. The statistics of the antimony industry in Canada in recent years are as follows:

Antimony produced in Canada, with imports and exports, 1913–1919, in short tons.

Year.	Ore produced.		Smelter production of metal.	Exports of ore.	Imports.	
	Total.	Metal content.			Metal.	Salts.
1913					334	12
1914					324	23
1915	1,341	525	30	1,149	981	34
1916	885	375	54	794	398	21
1917	361	120	(a)	(a)	(a)	(a)
1918	26	9				
1919	56	17	(a)	56	(a)	(a)

a No data.

[4] Wilson, A. W. G., Mining of antimony ores in Canada: Canadian Min. Jour., Feb. 15, 1917. Canada Dept. Mines, Mineral production, 1913–1919. Imp. Inst. Bull., vol. 14, pp. 401–403, 1916.

The principal producing district in Canada is at West Gore, Nova Scotia, where the ore in addition to antimony contains from 2 to 4 ounces of gold to the ton. Other regions that have produced antimony ore are New Brunswick (York County), British Columbia, Quebec, and Yukon Territory. In British Columbia (Slocan district) and Yukon Territory (Chieftain Hills) antimonial lead ores are also worked. The Nova Scotia ores, which furnished the bulk of the production, have been exported to England. The small production of refined antimony came chiefly as a by-product of lead refining at the smelter of the Consolidated Mining & Smelting Co., at Trail, British Columbia; a small quantity of antimony was also smelted from antimony ores by the New Brunswick Metals (Ltd.), formerly the Canadian Antimony Co., at Lake George, New Brunswick.

Canada appears to be in about the same position as the United States with reference to antimony mining. High prices continued over a long period will bring out a considerable production, but no output is to be expected at peace-time prices.

MEXICO.[5]

Deposits of antimony exist in many parts of Mexico, and a considerable quantity has been produced for many years. As in other countries the output was increased largely during the period 1915 to 1918. No reliable data as to mine production are available, but the following figures of exports to England and the United States and the reported production from 1912 to 1918 give some idea of the extent of the industry.

Antimony exported from Mexico, 1912–1919, in short tons.

Year.	To England: Crude and regulus.	To United States.	
		Ore.	Metal.
1912	3,296	.....	.....
1913	2,345	.....	.....
1914	1,543	.....	6
1915	(a)	520	.....
1916	(a)	1,339	.....
1917	(b)	1,775	790
1918	.....	1,449	2,660
1919	(a)	297	279

[a] No data. [b] Probably none.

Metallic antimony produced in Mexico, 1912–1919, in metric tons.

1912	3,500	1916[5a]	829
1913	2,340	1917	2,647
1914	1,570	1918	3,269
1915	200	1919	628

The principal mines are in the Sierra Catorce, in the States of San Luis Potosi and Queretaro. The ores are mixed sulphides and oxides

[5] Flores T., Los criaderos de antimonio de México: Bol. minero, vol. 1, pp. 193–195, 1916. Orchard, J. E., Mexico: Political and commercial control, p. 15, 1918. Weed, W. H., Handbook of Mines, 1918, pp. 1650–1651. Imp. Inst. Bull., vol. 14, p. 403, 1916.

[5a] Figures for 1916–1919 from Commerce Repts., Aug. 20, 1920, p. 883.

and carry from 5 to 50 per cent of antimony. A smelter with an annual capacity of 6,000 tons of metal was built at Wadley in 1900; the product formerly went principally to England, but since 1915 it has been marketed in the United States. The smelter and most important mines are owned by Cooksons, of England, through a subsidiary, the Republican Mining & Metal Co. American interests own other properties in the same region, and during the war a smelter was constructed at San Luis Potosi by the International Mining & Metal Co. In western Sonora, near the Gulf of California, there are deposits of oxidized ores which furnished a considerable part of the ore imported into the United States. These are owned by Americans. A large deposit of lead-antimony ore (jamesonite) at Zimapan, Hidalgo, owned by the Antimony Corporation, an American firm, has not yet reached a productive condition. Other deposits of possible importance are known in the States of Guerrero, Durango, Sonora, Mexico, Baja California, and elsewhere.

The disturbed condition of the country during the last few years has prevented a production of antimony commensurate with the probable capacity of the deposits. It is probable that production will be maintained in the future even during periods of low prices.

SOUTH AMERICA.

BOLIVIA.[6]

The production of antimony in Bolivia was negligible prior to the World War, but under the stimulus of high prices large quantities of high-grade antimony ore were produced from 1912 to 1918, as follows:

Metallic antimony produced in Bolivia, 1912–1918, in metric tons.

1912	40	1916	15,077
1913	30	1917	12,860
1914	102	1918	4,770
1915	9,859		

This ore was shipped principally to England until an embargo was placed on Bolivian ore in 1918. The chief producing region is in the southern part of the department of Potosi, particularly the Bustillo, Sur-Chicas, Nor-Chicas, and Porco districts. The ore is of high grade, the portion shipped averaging more than 50 per cent of antimony, but the veins are small and become barren at shallow depth. It is possible that the known deposits have been largely exhausted, and, although a recurrence of a like demand might result in new and valuable discoveries, it is not likely that Bolivia can be an important producer when prices are normal.

Ore shipments during the last few years have been as follows:

[6] Min. Jour. (London), Jan. 16, 1915, p. 45; Aug. 3, 1918. Mineral Industry for 1916. Singewald, J. T., and Miller, B. L., The mining industry of Bolivia: Eng. and Min. Jour., Dec. 9, 1916, p. 1005. Soc. Chem. Ind. Jour., vol. 38, p. 9 R, 1919. Bolivia, Comercio especial de Bolivia; exportación, importación, bancos, 1915, La Paz, 1916. Information furnished to War Minerals Committee by Western Metals Co. Consular Repts., July 31, 1920. Commerce Repts., Aug. 26, 1920.

Antimony ore shipped from Bolivia, 1913–1918, in metric tons.

Country.	1913	1914	1915	1916	1917	1918 (first 5 months).
England	62	186	16,184	17,377	13,887	2,189
France			.....	1,113	993	.....
Spain			140	.....	.....	.....
United States			1,599	4,258	3,460	727
	62	186	17,923	[a] 22,748	[a] 18,340	[a] 2,916

[a] Data from Western Metals Co. London Min. Jour. (Aug. 3, 1918) gives 25,845 metric tons as the production for 1916, and 21,287 metric tons as the production for 1917.

In 1918, 153 metric tons of ore was shipped to Chile, and 13 metric tons of "antimony bars" (presumably liquated antimony) was produced, of which 1 ton was shipped to England.

PERU.[7]

During the antimony boom of 1906–7 a small quantity of antimony ore was produced in Peru. No further production was made until 1915, when 522 tons of high-grade ore was mined. In 1916 the production rose to 1,876 tons of 60 per cent ore. The production in 1917 was 902 tons. In 1918 it decreased to 323 tons, and in 1919 there was exported only 60 tons.

Although deposits are known in many parts of the Republic, particularly the Departments of Huanuco, Ancachs, La Libertad, Cajamarca, and Junin, more than 90 per cent of the production has come from the Department of Puno, in southern Peru. Up to the present time it has been possible to mine antimony only during periods of high prices, but the deposits are said to be extensive, and it is possible that improved transportation facilities would result in some production under normal conditions.

Most of the ore produced in 1917 is said to have been exported to Japan.

EUROPE.

AUSTRIA-HUNGARY.[8]

The most important antimony deposits of the former Empire of Austria-Hungary are those of Hungary and Bohemia. Others of minor importance are those of Trojana in Carniola and Lessing and Maltern in Austria. The Hungarian deposits in 1912 furnished 872 tons of metal; in 1913, 11,017 tons of ore containing 1,038 tons of metal; and in 1917, 427 tons of metal and 67 tons of crude antimony.

In 1913 Austria produced 1,270 tons of ore, chiefly from one mine in Carniola, with minor quantities from small mines in Bohemia, but the production of metal was only 89 tons. The low antimony content of the Hungarian deposits is compensated by the gold content, and these deposits have been much more regular in production than those of the other parts of the Empire. So far as known the reserves

[7] Weckwarth, E., Antimonio en Perú; Cuerpo ing. minas Bol. 68, 1909. Estadística minera del Perú, 1915–1918. Information supplied by Western Metals Co. Soc. ing. Perú Inf. y mem., vol. 22, No. 8, 1920.

[8] Prindle, L. M., MS. report on antimony deposits in Europe, U. S. Geol. Survey, 1918. French Ministry of Blockade, report on antimony, 1917. Imp. Inst. Bull., vol. 14, pp. 392–393, 1916. Austrian and Hungarian official statistics.

are fairly large, but production can hardly be expected to increase greatly.

The productive capacity of both the Hungarian and the Bohemi deposits is probably sufficient to supply local needs in normal times and allow a surplus for export under favorable economic conditions Prior to the war exports of regulus went to Germany and smal quantities of ore to France and England. During the war the Central Empires probably depended largely on the Austro-Hungarian deposits for their antimony supplies, and owing to shortage of the metal, all the mines, including some whose operation had formerly been abandoned as unprofitable, were operated by the Austrian Government. The output is unknown, but it was probably considerably increased.[9]

FRANCE.[10]

France is the largest producer of antimony in Europe and also controls important productive deposits in Algeria and Indo-China. The following table gives the figures of French production as far as they are available:

Antimony produced in France in 1912–1919, in metric tons.

Year.	Mine production.		Smelter production.	
	Ore.	Metal content.	Regulus.	Oxide.
1912	11,018	2,392	5,406	
1913	20,872	6,467	3,394	2,996
1914	3,416	674	1,545	821
1915	6,353	1,116	2,834	912
1916	19,037	3,038	4,395	1,509
1917	19,453	2,942	4,534	1,485
1918	10,020	1,661	2,056	1,391
1919	4,123	1,230	1,565	483

The principal producing regions of France are Vendée, Mayenne, Cantal, and Haute-Loire. The French deposits are numerous, but for the most part small. The most important of them is La Lucette, in Mayenne, where stibnite associated with auriferous pyrite has been mined for many years. This deposit was considered to be approaching exhaustion, but it is reported that recent work has developed new ore bodies. The Lucette Co. has recently extended its holdings in other parts of France and has purchased properties in Algeria and Transvaal, and in 1911 it leased a smelter at Barcelona for the treatment of ores purchased abroad. The Lucette Co. is also associated with the Antimony & Compounds Co. of America.

France is normally an exporter of metallic antimony and the average annual exports during the period 1910–1914 amounted to about 2,000 metric tons. The principal purchasers were the United States, Germany, Italy, the Netherlands, and Russia. According

[9] Min. Jour. (London), Dec. 18, 1920.

[10] French Ministry of Blockade, report on antimony, January, 1917. Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918. Imp. Inst. Bull., vol. 14, pp. 393–395, 1916. French official statistics, 1912 and 1913.

to recent information,[11] the surplus production of antimony in France is now so large that the industry can hardly continue to exist on a paying basis, unless the producers come to an understanding among themselves. It is clear, however, that to be effective, any agreement among French producers must either be backed by a high protective tariff or be extended to include their principal foreign competitors.

During the war France imported much antimony ore.

Antimony ore imported into France, 1916–1919, in metric tons.[12]

1916	10,697
1917	13,665
1918	2,015
1919	1,866

GERMANY.

The production of antimony in Germany is too small to affect the world's market appreciably. There are a few localities that have possibilities of production if the price of antimony is sufficiently high. It is reported, that one plant in the Eifel district in 1915 was producing from 25 to 30 tons of regulus and 60 to 70 tons of oxide a month. There is, however, a production of antimonial lead from the smelters that may amount to the equivalent of 1,000 tons or more of antimony a year. This is derived in part from many German ores, especially the lead-zinc ores, and in part from ores of foreign origin.

Germany's interest in the antimony market is chiefly that of a smelter and middleman. Her average annual imports in 1910–1913 were as follows: Ore, 3,668 metric tons; metal, 3,398 tons; salts, 668 tons. Average annual exports were: Ore, 566 tons; metal, 331 tons; salts, 1,226 tons. The principal purchasers of the metal were the United States and Russia and of the salts Russia and England.

GREAT BRITAIN.[13]

Although deposits of antimony in Cornwall, Devon, and elsewhere were formerly worked, no antimony has been mined in England since 1892. Prior to the World War however, England was the chief smelting center of the world, several brands of British antimony, such as Cookson's and Hallet's, having a world-wide reputation. Deposits of considerable size exist in many of the British possessions.

England, through her smelting interests, has in the past played an important part in the antimony trade of the world. Seven smelters in England refine ore and crude metal, chiefly from China, but also from Mexico, Australia, and Hungary, and, during the war, large quantities from Bolivia and Spain. The better British brands have been considered purer than other grades and prior to the war virtually monopolized American markets.

British trading interests have exerted a large influence both in obtaining raw material for British smelters and in obtaining markets for British metal.

[11] Statistique de l'industrie minérale, 1914–1918, p. 124, Paris, 1919. Eng. and Min. Jour., vol. 107, p. 371, Feb. 22, 1919.
[12] Écho des mines et de la métallurgie, Mar. 27, 1919, quoted in Eng. and Min. Jour., vol. 107, p. 844, 1919.
[13] Imp. Inst. Bull., vol. 14, pp. 389–417, 1916. French Ministry of Blockade: report on antimony, 1917.

Until 1914 the Chinese Eastern Antimony Co., a subsidiary o Cookson & Co., held contracts for the output of the Wah Chan Mining & Smelting Co., the most important antimony producer i China, since, in addition to the mining of antimony ore, it control the local smelting industry. In 1914 the Wah Chang Co. establishe an independent selling agency in the United States.

ITALY.[14]

Italy ranks third as a producer of antimony in Europe. Th principal deposits are those in the southern part of the island o Sardinia. During the war, however, the Tuscan deposits wer reopened, and there was also a small production from Sicily. Th grade of the ore is low, probably averaging less than 25 per cent and the production, which was 7,609 tons of ore in 1900, had fallen i 1913 to 1,822 tons.

Antimony ore produced in Italy and metallic antimony imported, 1912–1917.

Year.	Ore produced.		Metallic antimony imported (metric tons).
	Quantity. (metric tons.)	Metal content (per cent).	
1912	1,878	20	.....
1913	1,822	25	.....
1914	555	24.5	191
1915	4,334	20	825
1916	6,509	.....	155
1917	5,789	.....	1,247

The low metallic content of the ore, together with the fact that in the Sardinian deposits the calcite gangue makes recovery more difficult, renders it probable that under peace-time conditions and prices Italy will not be an important factor in the world's production of antimony.

PORTUGAL.[15]

A small quantity of antimony ore was produced in Portugal—100 tons in 1912 and 19 tons in 1913. Exports of ore from Portugal in 1916 are said to have exceeded 4,000 tons. Nothing is known as to the grade of the ore or the possibilities of development. Mining methods are said to be crude and wasteful.

RUSSIA.[16]

Antimony and argentiferous lead-antimony deposits occur in the Ural Mountains and were reported to be under development in 1912. Antimony deposits are also reported in the Amur Province and in many localities in Siberia. It is possible that productive deposits may be developed in these regions, but nothing definite is known with regard to them.

[14] Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918. French Ministry of Blockade, report on antimony, 1917. Imp. Inst. Bull., vol. 14, p. 395, 1916. Italian official statistics.
[15] Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918. French Ministry of Blockade, report on antimony, 1917. Imp. Inst. Bull., vol. 14, pp. 395–396, 1916.
[16] De Hautpick, E., Min. Jour. (London), vol. 97, p. 620, 1912. Imp. Inst. Bull., vol. 14, p. 396, 1916.

In 1915 67 tons of regulus was imported into England from Russia. Possibly, however, this represents an overland shipment of Chinese material.

SERBIA.

Serbia contains several deposits of antimony of considerable promise, but the production has been small. The output of regulus and oxide, which amounted to 4,725 metric tons in 1904, had decreased to 297 metric tons in 1912. In 1917 the antimony ore produced at Trojani amounted to 2,176 tons. The greater part of the product was formerly shipped to the United States. Plants at two of the mines were said to be capable of a considerable production should conditions warrant it.

SPAIN.[17]

Deposits of antimony are known in many localities in Spain. For the most part the ore bodies are irregular and have been repeatedly worked and abandoned. In a few deposits, however, there appears to be some promise of a continued production. The production of ore and metal in recent years has been as follows:

Antimony ore and metal produced in Spain, 1911–1918, in metric tons.

Year.	Mine production of ore.	Smelter production of metal.	Year.	Mine production of ore.	Smelter production of metal.
1911	100	(a)	1915	300	(a)
1912	500	(a)	1916	516	425
1913	.....	(a)	1917	502	(a)
1914	.....	(a)	1918	60	(a)

a No data.

Shortly after the outbreak of the war three smelters were active, the largest of which was operated by the Lucette Co. (French).

Spain formerly imported annually 800 tons of antimony ore from France and prior to the war exported annually more than 100 tons of salts of antimony to Germany.

ASIA.

BORNEO.[18]

British Borneo was formerly a producer of considerable antimony and exported much ore between 1859 and 1894, mainly to England. The deposits then remained idle until 1914, when 870 tons of ore were exported; in 1915 the exports amounted to about 350 tons. It is probable that no large production at peace-time prices is to be expected, although the country is largely unexplored and there is the possibility of future valuable discoveries. The Borneo Co. appears to have been the principal if not the only producer.

[17] Estadística minera, 1912-1917. Prindle, L. M., MS. report on antimony in Europe, U. S. Geol. Survey, 1918. French Ministry of Blockade, report on antimony, January, 1917.

[18] Posewitz, T., Borneo, its geology and mineral resources, London, 1892. Imp. Inst. Bull., vol. 14, p. 397, 1916.

CHINA.[19]

Since 1908 more than 50 per cent and for the last several years more than 60 per cent of the world's production of antimony has come from China. In 1913 the production was estimated to be the equivalent of 13,032 metric tons of recoverable metallic antimony, and that of the whole world was about 24,500 tons. Being well established, the Chinese antimony industry was able to respond rapidly to the great demand of the World War. During the war China produced at more than double the rate of the world's peace-time consumption. The former annual production was more than doubled from 1914 to 1918, inclusive. In 1916 the exports reached their peak and amounted to the equivalent of 42,800 metric tons of metallic antimony. However, from 1917 to 1919, inclusive, there was a rapid decline in the exports, so that in 1919 they amounted to only about 9,000 tons, or 80 per cent less than in 1916. The decline for each of the several successive years was, respectively, about 28 per cent, 42 per cent, and 50 per cent.

Throughout the year 1919 the stock of the metal was 50 per cent below normal and the price was 64 per cent lower at the end than at the beginning of the year. The low price of the metal has caused great embarrassment to the industry.

No figures for production are available, but exports in recent years have been as follows:

Antimony exported from China, 1913–1919, in short tons.

	1913[a]	1914[a]	1915[b]	1916[b]	1917[c]	1918[d]	1919[d]
Regulus	14,361	21,649	23,931	24,740	36,254	19,965	9,724
Crude					21,805	1,060	1,484
Ore	4,795	5,479	1,843	12,968	8,667	530	638

[a] Imp. Inst. Bull., vol. 14, p. 392, 1916.
[b] Commerce Repts., Dec. 19, 1917.
[c] Steel and Metal Digest, p. 514, August, 1918. Commerce Repts., No. 57, Mar. 9, 1920.
[d] Min. Jour., vol. 130, No. 4437. Commerce Repts. (Suppl.), Dec. 7, 1920.

Antimony is found over widely scattered areas in the central and southern Provinces, but principally in Hunan, Yunnan, Kweichow, and Kwangsi. The deposits have been developed for the last two decades. Those in Hunan have been most extensively exploited, probably 90 per cent of the total production of China coming from the region about Changsha, the center of the smelting industry.

The most productive district in Hunan is Kai-keng-shan (Shikung-shan), in the valley of Tzu River, about 21 miles east of the Hsinhau. In 1915 about 70 companies mined antimony along the outcrop of the deposits in this district. The ore, which is mainly stibnite of remarkable purity, occurs as pockets and bunches in a flat bed of

[19] Imp. Inst. Bull., vol. 14, pp. 397–399, 1916. Moore-Bennet, A. J., The mineral area of western China: Far Eastern Rev., vol. 12, pp. 223–224, 1915. Wheler, A. S., Metalliferous mines of Hunan Province: Far Eastern Rev., vol. 12, p. 135, 1915; Antimony production in Hunan Province, South China: Inst. Mining and Metallurgy Bull. 137, 1916. New atlas and commercial gazetteer of China (compiled by the Far Eastern Geographical Establishment), North China Daily News and Herald (Ltd.), Shanghai. Min. Jour. (London), vol. 130, No. 4437, Sept. 4, 1920.

dolomitic limestone. Mining is carried on in a crude fashion by natives. Several local smelters produce liquated sulphide, and the output of the district in 1915 was about 1,000 tons monthly of crude ore averaging about 70 per cent metallic antimony. All regulus manufacture is controlled by the Wah Chang Co.

The Panshi district, which produces considerably less, is 25 miles from Chan-shi, on Tzu River, in a very mountainous region. The ore in this district occurs in a series of veins in upturned slates, shales, and quartzites. The output of the district in 1915 consisted of about 400 tons monthly of 30 per cent ore, all of which was shipped to the Wah Chang Co., at Changsha, for treatment.

Other producing districts in Hunan are the Wa-shi district, east of Shenchowfu; the Hua-pan-hsi district, in Anhwa; and the Chiang-hsi-lung district, in Chupu-hsien.

The only district in Yunnan where antimony is handled commercially is near Chihtsun, on the Tongking-Yunnan Railroad above Mengtse. The Pao Hua Co., connected with the Wah Chang Co., owns a French-constructed plant here and produces high-grade regulus.

During the period of war-time high prices some antimony was smelted and refined at various points in the provinces of Kwangtung and Kwangsi, but the smelters in these Provinces have now closed and the production has ceased.

The Wah Chang Mining & Smelting Co. largely controls the production of antimony ore, regulus, and crude in the province of Hunan. This company operates smelters in Changsha and owns certain mines of low-grade ore. It possesses a complete monopoly, granted by the Peking government, for the manufacture of regulus in Hunan and owns the patent rights in China for the Herrenschmidt furnace, the most successful means of reducing low-grade antimony ores. Most of the mines themselves are owned by natives and operated in a small way. In recent years there has been a tendency to smelt the ore at the mines, a procedure which promises to lower the cost of production.

Prior to the war exports of Chinese antimony were chiefly in the hands of English, French, and a few German firms. The New Chinese Antimony Co. (also known as the Chinese Eastern Antimony Co.), a subsidiary of Cookson & Co. of England, held a contract for the entire output of the Wah Chang Co. This contract was broken shortly after the war began, although the Wah Chang Co. paid a percentage on all sales to the New Chinese Antimony Co. for a year thereafter. The Wah Chang Trading Co. was organized as a direct selling agency in New York and has established a large business in this country.

Adverse exchange conditions due to the high price of silver have probably nearly doubled the cost of production in China, and at the same time wages in that country have advanced.

Chinese antimony, which suffered from lack of advertising before the war, being largely excluded by the British metal in this country, has now become firmly established in our markets.

The Bureau of Foreign and Domestic Commerce has issued a circular for investors (No. 30), telling how to acquire financial interest in antimony properties in China.

INDIA.[20]

During the war small quantities of antimony were produced in Burma and Mysore. The total Indian production of antimony ore was 1,040 tons in 1916 and 130 tons in 1917. The most productive region was the Amherst district of Burma. The ore reserves are said to be considerable, but the inaccessibility of the district has made production impossible except at high prices. No data are available as to the grade of ore shipped. The production from Mysore was only 26 tons in 1916. Antimony deposits, not worked at present, occur at several places in the Punjab and in the southern Shan States.

INDO-CHINA.[21]

There are productive deposits of possible future importance in French Indo-China. In 1916 these deposits produced 1,437 tons of antimony ore having a metal content of 642 tons. The metallic production in 1915, 1916, and 1917 was, respectively, 160, 642, and 101 metric tons. Smelters were operated by the firm of Schon & Rhay, and both native and Chinese ores were treated.

Antimony ore exported from Indo-China to France, 1914–1917, in metric tons.

1914	883
1915	630
1916	687
1917	[22] 129

JAPAN.[23]

Very little antimony ore has been produced in Japan since the development of the Chinese deposits, although as in most other countries there was a renewed development during the war. The smelting of Chinese ores has become an important industry and the smelter production, which was only 32 tons in 1914, rose to 8,300 tons in 1915 and to 10,800 tons in 1916. It was 6,700 tons in 1917. The production of metal and crude from domestic ores was only 186 tons in 1915 and 286 tons in 1916. The Japanese imports and exports from 1917 to 1919 were as follows:

Antimony imported into and exported from Japan, 1917–1919,[a] in metric tons.

Year.	Imports.	Exports.
1917	17,181	13,993
1918	6,246	[b] 2,685
1919	1,920	[b] 1,486

[a] Mineral Industry, 1919.
[b] Of the exports in 1918 and 1919, 1,626 and 1,645 tons, respectively, went to the United States, according to Commerce Reports, Nov. 4, 1920.

[20] Imp. Inst. Bull., vol. 14, p. 398, 1916. India Geol. Survey Rec., vol. 49, pt. 1, p. 13, 1918; pt. 2, p. 74, 1918; vol. 50, pt. 3, p. 143, 1919.
[21] Far Eastern Rev., vol. 13, p. 159, 1916. Eng. and Min. Jour., vol. 107, p. 371, 1919. Commerce Repts., June 25, 1917, p. 1140. Statistique de l'industrie minière, 1914–1918, Paris, 1919; idem, 1916–17, Paris, 1920.
[22] Statistique de l'industrie minérale for 1919 gives the exports for 1917 as 2,244 tons. This large discrepancy of 2,115 tons is probably the result of the shipments not arriving in France in the same year in which they were exported from Indo-China.
[23] Bliss, E. F., and Grout, F. F., MS. report to War Trade Board, 1918. French Ministry of Blockade, report on antimony, Jan. 31, 1917. Imp. Inst. Bull., vol. 14, p. 399, 1916. Commerce Repts., Feb. 19, 1919, p. 796. Statistique de l'industrie minérale, 1914–1918, Paris, 1919. Glückauf, 28 Aug., 1920, pp. 691–697. Résumé statistique de l'empire du Japon, 33e année, Tokyo, 1919.

It is probable that as long as cheap ore is available in China little production from Japanese deposits can be expected.

The extent to which Japanese ownership has been extended to Chinese mines is not known, but is probably small, as practically all Chinese antimony bought by Japan has been purchased in the open market in the form of crude and ore.

Since 1914 Japan has played a very considerable part in the smelting of Chinese ore and matte, ranking second only to China herself. China is now in a position to supply direct the greater part of the world's requirement of metal, having largely extended her facilities for treating antimony ores, and it is doubtful whether Japanese smelters will long be able to compete successfully with the Chinese.

As most of the ships available on the Pacific during the war were Japanese, most of the antimony trade was in Japanese hands, and Japanese firms could land antimony in New York by way of Panama more cheaply than other firms. How far this control will be continued or extended under normal peace conditions is problematic.

TURKEY.[34]

The production of antimony in the Turkish Empire comes from the vilayets of Brusa and Smyrna, particularly the region between Kutaya and Aidin, in eastern Asia Minor. The deposits appear to be rich and capable of greater development. Bad government, lack of transportation facilities, and excessive export duties have retarded production. Some mines were the property of the Sultan, and their development was hindered by excessive royalties. Most of the mines appear to be owned or leased by Greeks. Deposits of antimony ores associated with argentiferous lead ores are reported to occur in the vicinity of Karahissar, in Armenia. Undeveloped deposits of possible importance occur in the islands of Mytilene and Chios, now in Greek ownership. The productive district of Allchar, formerly in European Turkey, was acquired by Serbia after the Balkan War.

Few data are available as regards the production of antimony in Turkey. In 1911 the Djinli Kaya mine, near Eudemish, produced 1,500 tons of 50 per cent ore. The production of Asia Minor in 1912 is reported as 677 tons of ore. Exports of antimony ore from Turkey to Great Britain were 303 metric tons in 1910, 773 tons in 1911, 1,091 tons in 1912, 402 tons in 1913, and 199 tons in 1914. Some ore was also shipped to Austria, and in 1913, 205 tons went to France.

It seems probable that, given good government and improved transportation, an increased output could be obtained from the region even at peace-time prices, as according to the best available information the deposits are large and much of the ore is of high grade.

[34] Simmersbach, B., Die nutzbaren mineralischen Bodenschätze in der klein asiatischen Turkei: Zeitscher. für Berg, Hutten u. Salinenwesen, vol. 52, p. 533, 1904. Doelter, C., Die Mineralschätze der Turkei: Montan, Rundschau, vol. 8, p. 219, 1916. Dominian, L., Mineral resources of the Turkish Empire: Min. and Sci. Press, vol. 98, p. 824, 1909. Weiss, K. G., Mitteilungen über Lagerstätten in westlichen Anatolien: Zeitschr. prakt. Geologie, vol. 11, p. 255, 1901. Schmeisser, C., Bodenschätze und Bergbau Kleinasiens: Zeitschr. prakt. Geologie, vol. 14, p. 192, 1906. Thomae, W. F. A., Emery, chrome ore, and other minerals in the vilayet of Aidin, Asia Minor: Am. Inst. Min. Eng. Trans., vol. 28, p. 221, 1898. Harris, E. L., consular report quoted in Eng. and Min. Jour., vol. 84, p. 689, 1907. French Ministry of Blockade, report on antimony, Jan. 31, 1917.

AFRICA.

ALGERIA.[25]

The Algerian deposits are probably capable of considerable development, as is shown by the response to the increased demand in 1915 and 1916. The ores are nearly all oxidized and contain various rare antimony minerals. Prior to the war the chief product consisted of antimonate of iron mined together with lead and zinc ores at Haman N'Bails. During the war large deposits of oxide ores were developed at Aïn Kerma and were reported to be supplying antimony to France at the rate of 300 tons a month in the early part of 1918. After the war the decline in production was rapid. The following table shows the mine production during recent years:

Antimony ore produced in Algeria, 1912–1919, in metric tons.

Year.	Ore.	Metal content.	Year.	Ore.	Metal content.
1912	4,661	1,771	1916[a]	28,473	11,176
1913	582	233	1917	16,248	5,686
1914[a]	1,100	400	1918	7,920	2,772
1915[a]	9,022	3,428	1919	2,160	756

[a] Exports, metal content approximate only.

BRITISH SOUTH AFRICA.

Several antimony deposits are known in British South Africa, of which the most promising appear to be those of the Murchison Range,[26] in northern Transvaal. Here auriferous stibnite occurs as veins and replacement deposits in limestone over a considerable area. The ore as mined carries from 3½ to 8 pennyweights of gold ($3.60 to $8.25) to the ton and 7 to 10 per cent of antimony.

Concentrates and crude antimony shipped from Transvaal, 1913–1918, in metric tons.

1913	48	1916	722
1914	0	1917	617
1915	91	1918	99

The principal mine of the range, the United Jack, was purchased in 1917 by the Lucette Co. (French). In 1916 there were four producing mines in the district.

The antimony deposits of the Steynsdorp district,[27] near the Swaziland border, were reported to be under development in 1916, and deposits of antimony ore are known in the Forbes Reef district, in Swaziland.

Antimony ores are found over a considerable portion of southern Rhodesia,[28] and this district would probably be capable of a considerable output with better transportation facilities and continued high

[25] Dussert, Étude sur les gisements métallifères de l'Algérie: Annales des mines, 10th ser., vol. 7, 1910. French official statistics. French Ministry of Blockade, report on antimony, 1917. Echo des mines et de la métallurgie, vol. 46, p. 297, June 16, 1918. Metall und Erz, Jahrg. 17, Heft 7, p. 182; Apr. 8, 1920. [1917–1919 said to be figures of the Algerian Export Bureau.]

[26] Hall, A. L., Geology of the Murchison Range: South Africa Geol. Survey Mem. 6, 1912. Union of South Africa, Reports Govt. Mining Engineer, 1914–1917.

[27] South African Min. Jour., vol. 25, pt. 2, p. 479, Aug. 26, 1916. Molengraaf, G. A. P., Géologie de la République sud-africaine: Soc. Géol. France Bull., 4th ser., vol. 1, p. 28, 1901.

[28] South African Min. Jour., vol. 25, p. 465, Aug. 19, 1916. Reports of the Secretary of Mines of Rhodesia, 1916–17.

prices. The ore produced in 1916 and 1917 amounted to 38 and 15 tons, respectively. Some of the mines, such as the Hope Fountain, near Bulawayo, are valuable chiefly for their production of gold, with antimony as a minor by-product.

AUSTRALIA.[29]

The only important antimony-producing district in Australia is the Costerfield district of Victoria. Here stibnite and antimony oxides occur in quartz veins cutting Ordovician slates.

The antimony concentrates, which average about 48 per cent of antimony and also contain about 2½ ounces of gold to the ton, are shipped to England.

The output in recent years has been as follows:

Antimony concentrates produced in Victoria, 1913–1919.

Year.	Quantity (long tons).	Value.
1913	2,527	$152,830
1914	2,439	142,745
1915	a3,200	.....
1916	3,259	375,828
1917	(b)	(b)
1918	1,201	116,737
1919	1,208	117,417

a Approximate. b No data.

The Hillgrove district in New South Wales was formerly a considerable producer, the highest annual output being 2,450 tons of ore in 1906.

Antimony metal and ore produced in New South Wales, 1912–1919.

Year.	Quantity (long tons).	Value.	Year.	Quantity (long tons).	Value.
1912	62	$1,727	1916	616	$64,850
1913	18	1,979	1917	301	18,180
1914	36	2,252	1918	358	15,333
1915	632	60,885	1919	87	11,382

Apparently the greater part of the production is shipped as crude.

Insignificant quantities of antimony ore have recently been produced in Queensland and Western Australia. New Zealand produced a small quantity during the boom of 1906 and 1907, but no production is recorded since 1910.

Imports of antimony ore into Great Britain from Australia in 1915 amounted to 3,854 long tons, valued at $471,700.

[29] Official statistics, Victoria and New South Wales. Imp. Inst. Bull., vol. 14, pp. 405–408, 1916. Caine, J. E., The antimony mining industry in New South Wales; New South Wales Dept. Mines, Min. Res. 16, 1912. Victoria Sec. Mines Ann. Rept. 1918, p. 5. Chem. Eng. and Min. Rev., vol. 12, No. 141, p. 325, 1920.

LEAD.

By C. E. Siebenthal and A. Stoll.

SUMMARY.

The following tabular statement gives the general items regarding domestic production and consumption of refined lead from figures compiled by the United States Geological Survey:

Summary of statistics of refined lead, 1918–19, in short tons.

	1918	1919
PRODUCTION.		
Domestic desilverized lead	282,024	208,751
Domestic soft lead	210,463	147,744
Domestic desilverized soft lead	47,418	67,938
	539,905	424,433
Foreign desilverized lead	100,290	57,787
Total primary [a] lead	640,195	482,220
Antimonial lead	18,570	13,874
Secondary [a] lead	97,100	122,100
CONSUMPTION.[b]		
Apparent consumption of primary lead, stocks disregarded	542,975	434,143

[a] "Primary lead," which is produced directly from ore, is here distinguished from "secondary lead," which is obtained by refining skimmings, drosses, and old metals. The statistics of secondary lead are given on p. 320. Wherever in this report the word "lead" is used without qualification it means primary lead.

[b] For method of calculating consumption see p. 329.

The output of refined lead in the United States from domestic ores in 1919 was 424,433 short tons, having a value of $44,990,000, based on the total sales of pig lead in 1919, as compared with 1918 a loss in quantity of 21 per cent and a loss in value of 41 per cent.

INTRODUCTION.

An estimate of the production of refined lead in 1919, based on reports received from every lead smelter in operation, was published by the United States Geological Survey on January 2, 1920. This estimate included the actual production for the first 10 or 11 months of 1919 and estimates for the remainder of the year. The complete figures for the production and consumption of refined primary lead and for the imports and exports of lead in ore and bullion were given in the preliminary report on the mineral resources of the United States in 1919, published September 8, 1920. The present report contains, in addition to the statistics given in the preliminary report, tables showing production, consumption, imports, exports, and prices for a period of years.

The statistics of production of lead in this country in 1919 have been compiled by the Geological Survey from confidential reports submitted by each lead-smelting company in operation during the year. The statistics of the recovery of secondary lead were also collected by the Geological Survey. The statistics of domestic consumption of refined lead are taken in part from the refinery returns and in part from the records of the Bureau of Foreign and Domestic Commerce, of the Department of Commerce, and the statistics of foreign production are compiled from the sources indicated in connection with the tables here presented.

PRODUCTION.

QUANTITY AND VALUE.

The refined lead produced in the United States from 1720 to 1914 from domestic ores and from foreign ores and base bullion and its value at the average price in New York are shown in a table in the chapter on lead in Mineral Resources for 1914. Details for years later than 1905 are shown in the table below.

Production, price per pound, and value of refined lead in the United States, 1720–1919.

Year.	Desilverized lead.[a,b]	Soft lead.[c]	Total production.[b]	From domestic ores and base bullion.[b]	From foreign ores.	From foreign base bullion.	Price per pound at New York.[d]	Value.
	Short tons.	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*	*Short tons.*		
1720–1905	5,251,079	2,081,836	7,332,915	6,032,383	1,300,532		.....	$634,403,000
1906	313,886	90,860	404,746	336,200	28,803	39,743	$0.057	46,141,000
1907	313,588	99,801	413,389	352,381	24,041	36,967	.053	43,819,000
1908	295,552	101,012	396,564	311,666	11,509	73,389	.042	33,311,000
1909	329,751	117,158	446,909	352,839	21,754	72,316	.043	38,434,000
1910	328,954	141,318	470,272	375,402	18,065	76,805	.044	41,384,000
1911	331,032	155,947	486,979	391,995	10,764	84,220	.045	43,828,000
1912	339,646	141,248	480,894	392,517	11,572	76,805	.045	43,280,000
1913	330,593	131,867	462,460	411,878	13,223	37,359	.044	40,696,000
1914	383,903	158,219	542,122	512,794	7,639	21,689	.039	42,286,000
1915	388,594	161,461	550,055	507,026	9,581	33,448	.047	51,705,000
1916	403,619	167,515	571,134	552,228	6,085	12,821	.069	78,817,000
1917	422,266	188,503	610,769	548,450	15,872	46,447	.086	105,052,000
1918	429,732	210,463	640,195	539,905	15,334	84,956	.071	90,908,000
1919	334,476	147,744	482,220	424,433	7,656	50,131	.053	51,115,000
	10,196,671	4,094,952	14,291,623	12,042,097	2,249,526		.....	1,385,179,000

[a] Desilverized soft lead is included; for quantity see p. 317.
[b] Antimonial lead is excluded; for quantity see p. 318.
[c] Desilverized soft lead is excluded.
[d] For 1917, 1918, and 1919, average sales price.

PRODUCTION BY STATES.

The production of refined lead can with difficulty be apportioned according to sources of ore, owing to the fact that lead refiners treat products already smelted, whose origin may, as in custom refining, be unknown to them, because the identity of the ore is preserved only as far as the smelter. Accordingly, the following table is compiled, so far as possible, from smelter figures. It includes "pig lead" reported by all smelters running on Mississippi Valley or other "soft" lead ores and "work lead" produced at all other lead smelters, except that the greater part of the product reported by silver-lead smelters operated in conjunction with refineries is stated

in terms of refined lead. A like part of the antimonial lead is thus eliminated from the "work lead" produced and appears only in the figures of production of antimonial lead.

In addition to the domestic lead ores smelted in this country, small quantities of domestic lead ore have been exported to smelters in Canada. In 1912 soft lead amounting to 63 tons was smelted from Wisconsin ores at Canadian smelters, and in 1913 soft lead amounting to 37 tons from Wisconsin ores and desilverized lead amounting to 98 tons from Idaho and Washington ores were smelted at Canadian smelters. The desilverized lead smelted in Canada from Washington ores amounted to 31 tons in 1914, to 137 tons in 1915, and to 2,001 tons in 1916. In 1917 silver-lead ores from Idaho and Montana smelted in Canada produced 4,570 tons of lead. Ores from Washington yielded 1,388 tons of lead at Canadian smelters in 1918 and 3 tons in 1919.

Primary lead smelted or refined in the United States, 1907–1919, by sources, in short tons.

Source of ore.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Domestic ore:													
Alaska	.....	3	69	75	51	45	6	.....	358	659	884	531	645
Arizona	2,418	1,464	1,507	948	3,428	3,891	4,901	5,601	6,953	15,328	7,456	6,195	5,407
Arkansas[a]	15	.....	14	.....	15	.....	.....	52	51	170	300	14	.....
California	938	515	977	1,207	615	811	3,294	3,698	5,606	3,633	11,471	6,228	2,004
Colorado	52,552	28,729	30,865	38,542	30,442	37,039	42,840	41,198	32,352	33,046	29,327	29,395	18,867
Idaho	123,292	98,464	103,747	109,951	117,335	127,780	137,802	177,827	160,680	170,059	174,045	142,640	89,091
Illinois[a]	498	362	273	263	308	513	619	427	910	670	867	1,010	977
Iowa[a]	225	110	15	.....	.....	.....	.....	34	.....	.....	.....	.....	.....
Kansas[a]	1,798	2,293	2,763	1,308	2,522	1,937	1,504	1,043	1,320	1,737	2,663	5,023	7,951
Kentucky[a]	75	.....	.....	50	.....	91	16	16	95	37	21	109	83
Missouri[a]	122,856	122,451	141,105	161,659	182,203	162,610	152,430	194,275	195,634	218,253	218,197	187,743	150,341
Montana	2,145	2,320	1,451	1,943	2,484	2,517	3,256	4,386	4,853	4,961	5,933	17,586	17,513
Nevada	3,480	3,796	4,792	2,246	1,082	5,699	6,142	5,996	7,664	11,858	12,334	8,726	5,958
New Hampshire	.....	.....	.....	.....	.....	.....	.....	.....	3	46	.....	.....	16
New Mexico	2,047	586	1,350	1,890	1,371	2,511	1,821	741	2,157	3,290	3,428	5,140	1,418
New York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	49	.....
North Carolina	.....	.....	.....	2	35	34	10	.....	.....	.....	.....	.....	.....
Oklahoma[a]	404	1,409	2,268	1,805	1,925	2,500	3,214	3,916	4,346	10,969	19,646	58,755	49,984
Oregon	5	7	7	.....	11	21	37	17	11	9	.....	6	.....
South Dakota	.....	13	.....	8	33	12	7	2	5	12	34	28	18
Tennessee[a]	16	.....	.....	.....	.....	.....	.....	.....	8	.....	.....	843	2,371
Texas	12	42	44	36	57	30	108	89	111	26	58	30	8
Utah	55,540	42,455	66,648	60,605	54,933	60,664	71,069	88,976	106,105	111,789	82,081	76,169	65,102
Virginia[a]	83	13	.....	87	400	85	878	143	457	740	147	59	.....
Washington	341	391	120	339	612	53	9	2	11	217	929	906	1,090
Wisconsin[a]	3,573	4,013	3,252	3,909	3,966	3,301	2,639	1,819	2,632	3,121	2,930	4,275	3,975
Undistributed	896	36	317	101	48	120	63	99	128	113	145	59	119
Zinc residues	1,890	1,290	1,735	2,237	1,987	3,131	3,765	4,125	4,562	5,478	6,489	5,359	4,887
	375,099	310,762	363,319	389,211	405,863	415,395	436,430	534,482	537,012	596,221	579,385	556,878	427,825
Foreign ore:													
Africa	288	.....	3,150	3,310	582	1,774	5,976	2,942	.....	328	1,738	1,519	644
Australia	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	282	69
Canada	2,607	162	66	25	122	29	16	2	1,174	1,231	1,100	7,550	1,895
Central America	23	12	20	3	28	.....	.....	.....	1	7	.....	.....	12
Mexico	20,204	10,145	16,944	11,704	7,333	7,407	4,512	2,386	5,437	1,917	7,607	4,798	2,261
South America	919	1,186	1,536	2,996	2,677	2,332	2,617	1,821	2,829	2,366	1,533	1,101	2,537
Other foreign	.....	4	38	27	22	30	102	488	140	236	3,894	84	238
Foreign base bullion:													
Canada	2,716	179	1,500	.....	.....	.....	.....	.....	.....	1,072	6,750	8,108	567
Mexico	34,251	73,210	70,816	76,805	84,220	76,805	37,359	21,689	33,173	11,598	39,508	76,809	49,564
South America	.....	.....	.....	.....	.....	.....	.....	.....	275	151	189	39	.....
	61,008	84,898	94,070	94,870	94,984	88,377	50,582	29,328	43,029	18,906	62,319	100,290	57,787
Grand total	436,107	395,660	457,389	484,081	500,847	503,772	487,012	563,810	580,041	615,127	641,704	657,168	485,612

[a] The lead produced by these States is nonargentiferous or soft lead.

SOFT LEAD.

The lead ores of the Mississippi Valley are almost free from silver and the lead produced from them is known as "soft lead."

A little lead ore of this kind is also mined in Washington and other Western States, but this ore has been generally smelted by plants treating argentiferous lead ore, and thus the resulting lead has not been distinguished from the desilverized product of those plants. With two exceptions, the smelters running exclusively on these soft-lead ores do not desilverize their product. Their output is shown in the column headed "Soft lead" in the table on page 314, giving the production of refined lead for 1720–1919. However, considerable soft-lead ore has been annually smelted and some purchased soft pig lead has been desilverized by the silver-lead smelters. Since 1904 the St. Louis Smelting & Refining Co. has regularly desilverized its product. In 1915 the St. Joseph Lead Co. installed desilverizing kettles, and a part of its product has since been desilverized. This desilverized soft lead, for the years prior to 1906, has not been recorded separately from the lead produced from silver-lead ores, though the lead content of the soft-lead ores so smelted and desilverized has been recorded since 1894. Since 1906 the quantity of soft lead produced by each State has been recorded, as shown in part in the preceding table. In the following table the undesilverized output of the soft-lead smelters is given in the first column and the refined lead output from soft-lead ores smelted and desilverized is given in the second column. The figures do not give the total quantity of lead recovered from soft-lead ores, for the lead recovered in the form of pigments, which are made principally from soft-lead ores, should be taken into account. The lead content of pigments smelted directly from ore in 1919 is given in the fourth column, and the total output of soft lead in the fifth column. The percentage which the total production of soft lead makes of the total domestic production of lead, composed of refined domestic lead plus lead in pigments and lead in antimonial lead, is shown in the last column. As will be noted, the percentage ranges from 37 to over 50 in the period under review. A little foreign lead is incorporated in the lead content of the leaded zinc pigment, but as it is difficult to determine just what quantity is involved it has been disregarded.

Soft lead produced in the United States, 1907–1919, in short tons.

Year.	Soft pig lead.			Soft lead recovered in pigments.	Total soft lead.	Total domestic lead.[a]	Soft-lead percentage of total domestic lead.
	Undesilverized.	Desilverized.	Total soft pig lead.				
1907	99,801	29,829	129,630	6,574	136,204	365,506	37
1908	101,012	29,869	130,881	7,377	138,258	326,657	42
1909	117,158	32,532	149,690	7,292	156,982	367,393	43
1910	141,318	27,952	169,270	7,603	176,873	391,543	45
1911	155,947	35,667	191,614	7,678	199,292	407,767	49
1912	141,248	29,789	171,037	10,323	181,360	410,159	44
1913	131,867	29,433	161,300	10,998	172,298	435,343	40
1914	158,219	43,506	201,725	11,914	213,639	537,676	40
1915	161,461	44,001	205,462	12,782	218,244	536,312	41
1916	167,515	68,244	235,759	13,252	249,011	580,225	43
1917	188,503	56,268	244,771	12,870	257,641	574,338	45
1918	210,463	47,418	257,881	13,093	270,974	562,218	48
1919	147,744	67,938	215,682	11,479	227,161	444,250	51

[a] Includes domestic refined lead, domestic lead in antimonial lead, and domestic lead in pigments.

ANTIMONIAL LEAD.

The production of by-product antimonial lead from argentiferous lead ores derived from all sources, as reported by all lead refineries operating in this country, is shown for the period 1871–1906 (earlier years being estimated from the output of desilverized lead) in a table in the chapter on lead in Mineral Resources, 1914. The figures for later years are given in the table below. Since 1909 producers have been asked to distinguish between the by-product antimonial lead derived from ore and bullion of foreign origin and that from domestic ores. Inasmuch as the antimonial skimmings are worked up in batches, the output of antimonial lead in any one year does not necessarily correspond strictly to the bullion refined during that year, hence the output of antimonial lead is distributed as between domestic and foreign in proportion to the lead refined from domestic and from foreign bullion during the year. The total antimonial lead produced during the period 1907–1919 was equal to 5.13 per cent of the total lead refined from domestic and foreign bullion during that period.

By-product antimonial lead produced in the United States, 1907–1919.

Year.	Total lead refined from base bullion (short tons).	Percentage of by-product antimonial lead.	Antimonial lead.						
			From domestic ore (short tons).	From foreign ore (short tons).	Total.				
					Quantity (short tons).	Value.	Antimony content.		Lead content, by difference (short tons).
							Short tons.	Percentage.	
1907	283,759	3.5	7,780	2,130	9,910	$1,322,985	1,561	15.8	8,349
1908	265,683	5.1	9,274	4,355	13,629	1,264,771	2,440	17.9	11,189
1909	297,219	4.3	8,889	4,007	12,896	1,231,019	2,360	18.3	10,536
1910	301,002	4.7	10,140	3,929	14,069	1,338,090	2,229	15.8	11,840
1911	295,365	4.8	9,636	4,442	14,078	1,380,556	2,254	16.0	11,824
1912	309,857	4.4	8,549	5,003	13,552	1,311,348	1,949	14.4	11,603
1913	301,160	5.5	14,667	1,998	16,665	1,591,854	2,508	15.0	14,157
1914	340,397	4.9	15,475	1,192	16,667	1,572,167	2,693	16.2	13,974
1915	344,593	6.7	19,371	3,853	23,224	3,665,736	3,425	14.8	19,799
1916	335,375	7.2	17,246	6,792	24,038	4,483,582	3,496	14.5	20,542
1917	365,998	5.1	15,279	3,367	18,646	3,781,560	2,759	14.8	15,887
1918	382,314	4.9	10,777	7,793	18,570	2,826,350	2,566	13.8	16,004
1919	266,538	5.2	9,674	4,200	13,874	1,513,968	1,943	14.0	11,931
Average		5.13						15.3	

Details of the production and consumption of antimony in the United States are given in the chapter on antimony in Mineral Resources, 1919.

LEAD PIGMENTS.

PIGMENTS SMELTED DIRECTLY FROM ORE.

In addition to leaded zinc oxide and zinc-lead oxide, which are noted more particularly in connection with the production of zinc pigments, two other lead pigments are made directly from ore, namely, sublimed white lead and sublimed blue lead. Sublimed white lead consists of lead sulphate 75 per cent, lead oxide 20 per cent, and zinc oxide 5 per cent. Sublimed blue lead consists of lead sulphate 50 to 53 per cent, lead oxide 41 to 38 per cent, with small proportions of lead sulphide, lead sulphite, and zinc oxide. Zinc-lead oxide contains from 46 to 50 per cent of lead sulphate, from 52 to 46 per cent of zinc oxide, and a small quantity of zinc sulphate. No zinc-lead oxide is made at present. Leaded zinc oxide may vary from 4 to 20 per cent in lead sulphate, the remainder being zinc oxide, with a small portion of zinc sulphate.

The lead content of pigments smelted directly from ore is given in the fourth column of the table on page 317. As there are but two producers of sublimed lead or basic lead sulphate, the output may not be revealed. The production of leaded zinc oxide is given in the chapter on zinc.

PIGMENTS MANUFACTURED FROM PIG LEAD.

The pigments manufactured from pig lead, which are white lead, red lead, orange mineral, and litharge, show a decrease in average price per ton of 10 per cent from the average in 1918, corresponding to a decrease of 25 per cent in the average price of pig lead. There was, however, an increase in the output of each except litharge. White lead in particular made a noteworthy gain.

Manufactured lead pigments marketed in the United States, 1918–19.

Pigment.	1918			1919		
	Quantity (short tons).	Value.		Quantity (short tons).	Value.	
		Total.	Per ton.		Total.	Per ton.
White lead:						
In oil	82,799	$17,224,480	$208.03	109,005	$21,579,234	$197.97
Dry	20,089	3,542,368	176.33	30,085	4,845,788	161.07
Red lead and orange mineral	30,069	5,928,597	197.17	32,362	5,314,255	164.21
Litharge	48,874	8,825,724	180.58	46,739	6,431,801	137.61

SECONDARY LEAD.

Secondary lead is obtained mainly from skimmings, drosses, old metal, and alloys, such as babbitt, solder, and type metal. The recovery of lead by refining these materials constitutes an integral part of the lead industry. This business is carried on mostly at small refineries scattered over the United States, but the large smelters and refineries working primary lead frequently find it advantageous to incorporate material from secondary sources. The

product of the secondary refineries is of two classes—pig lead and lead in alloys. The lead in alloys may have been recovered in the form of pig lead and alloyed at the refinery, or it may have been refined as an alloy, being brought to the desired composition by the addition of the requisite metal.

Secondary lead recovered in the United States, 1909–1919, in short tons.

Year.	Pig lead.	Lead in alloys.	Total recovered lead.	Value.
1909	18,360	23,327	41,687	$3,585,000
1910	29,492	25,930	55,422	4,877,000
1911	27,389	26,895	54,284	4,886,000
1912	30,266	36,902	67,168	6,045,000
1913	33,104	39,730	72,834	6,409,000
1914	29,337	31,725	61,062	4,763,000
1915	36,400	42,500	78,900	7,416,000
1916	56,700	39,600	96,300	13,289,000
1917	45,100	48,400	93,500	16,082,000
1918	41,146	55,954	97,100	13,788,000
1919	55,684	66,416	122,100	12,943,000

MINE PRODUCTION.

The preceding tables give the quantity of lead recovered by smelting and refining operations either as metallic lead, or in the alloy antimonial lead, or as lead in pigments. The following table shows the source or derivation of the domestic lead that is recovered by smelting and refining operations. The origin of the lead is much more accurately shown by the mines reports, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual output of metallic lead may not correspond at all closely to the product of the mines for the same year. The data for this table are taken from the chapters on gold, silver, copper, lead, and zinc in the Eastern, Central, and Western States.

It should be understood that strict comparisons between the States are not possible, because the form of statement is not uniform, the lead being stated as recovered lead in some States, lead content in others, and as partly one and partly the other in still other States. It is hoped that this practice, which is largely necessitated by conditions, can be soon abandoned in favor of stating the lead as recovered metal.

MINE PRODUCTION, 1907–1919.

The following table gives the output of lead since 1907, the first year in which there were mines reports for all lead-producing States. Missouri holds first rank in mine production of lead throughout the period, with Idaho in second and Utah in third place. Colorado held fourth place until 1918 when Oklahoma went into that rank.

Mine production of lead by States, 1907–1919, in short tons

State.	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Alaska	.....	.....	19	28	24	.....	18	28	437	820	852	564	687
Arizona	2,330	1,504	1,549	1,348	5,137	3,403	8,072	7,502	10,869	13,531	11,733	6,252	5,102
Arkansas	12	15	24	63	64	31	18	41	63	272	382	120	28
California	1,313	619	751	1,435	699	572	1,757	2,126	2,290	6,204	10,934	6,686	1,784
Colorado	42,703	26,100	36,084	38,036	34,840	37,621	43,949	37,106	34,405	35,457	33,995	32,980	18,535
Idaho	116,912	103,414	107,993	114,129	136,278	142,093	158,936	174,263	173,000	187,541	196,780	147,348	91,171
Illinois	830	399	295	373	964	1,282	959	717	954	1,072	1,439	2,273	2,105
Iowa	242	51	36	20	60	63	65	.....	.....	14	34	.....	.....
Kansas	2,555	2,518	1,300	2,412	2,859	2,371	2,427	1,409	1,212	1,648	3,025	7,252	11,283
Kentucky	34	.....	10	41	.....	106	22	16	251	153	123	185	86
Maine	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
Missouri	138,675	144,459	159,435	161,016	178,868	177,069	176,116	192,612	210,440	233,088	234,156	194,175	163,290
Montana	1,874	2,298	1,492	2,053	3,216	3,723	5,468	4,828	6,878	6,798	10,976	18,568	17,219
Nevada	3,136	3,623	4,920	2,436	1,632	9,750	8,172	6,405	8,319	12,819	13,839	11,658	7,675
New Hampshire	.....	.....	.....	.....	.....	.....	.....	.....	3	47	48	30	.....
New Mexico	1,905	437	2,515	2,160	1,483	2,747	1,973	882	2,271	4,107	4,554	4,199	1,443
New York	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	29	.....
North Carolina	.....	.....	.....	.....	.....	46	.....	.....	.....	.....	1	.....	.....
Oklahoma	532	1,781	3,427	2,888	2,501	3,388	6,228	7,556	7,306	12,115	26,358	56,097	53,872
Oregon	.....	1	.....	.....	.....	20	44	8	31	14	.....	5	.....
Pennsylvania	.....	.....	.....	.....	.....	.....	.....	.....	6	.....	.....	.....	.....
South Dakota	.....	12	59	7	32	11	5	2	2	18	34	27	16
Tennessee	.....	.....	.....	.....	.....	.....	.....	.....	1	16	2,531	1,705	2,188
Texas	12	33	46	33	61	33	113	75	110	25	1	13	7
Utah	57,969	44,389	74,243	61,662	68,248	70,156	83,063	85,662	99,984	100,745	89,261	83,504	61,915
Virginia	70	38	.....	99	417	235	816	127	339	728	859	815	.....
Washington	410	575	144	661	424	64	101	33	148	2,700	4,895	2,636	1,073
Wisconsin	3,499	4,138	3,694	4,413	3,353	2,581	1,866	1,494	2,322	3,043	4,139	4,533	4,214
	375,013	336,404	398,036	395,313	441,160	457,365	500,188	522,892	561,641	622,975	650,949	581,654	443,694

COMPARISON OF TOTALS BASED ON SMELTER RETURNS AND ON MINE RETURNS.

The statistics of lead actually recovered by the smelters as refined pig lead, in antimonial lead, and in pigments, and the statistics of mine production (lead content of ores produced) are compared over a period of years in the following table:

Domestic lead recovered and lead mined in the United States, 1907–1919, in short tons.

Year.	From smelter reports.	From mine reports.	Smelter excess	Mine excess.
1907	365,506	375,013	.....	9,507
1908	326,657	336,404	.....	9,747
1909	367,393	398,036	.....	30,643
1910	391,543	395,313	.....	3,770
1911	407,767	441,160	.....	33,393
1912	410,159	457,365	.....	47,206
1913	435,343	500,188	.....	64,845
1914	537,676	522,892	14,784	.....
1915	536,312	561,641	.....	25,329
1916	580,225	622,975	.....	42,750
1917	574,338	650,949	.....	76,611
1918	562,218	581,654	.....	19,436
1919	444,250	443,694	694,556	.....
	5,939,387	6,287,284	.....	347,897

The smelter totals represent actual recovery and are found by summing up the total production of refined lead reported by all companies, by calculating the lead content of domestic antimonial lead, and recalculating all pigments back to equivalent metallic lead on the basis of average analysis of product. The lead recovered from secondary sources is excluded from these totals, as it has already been reckoned once as pig lead. In collecting the data for compiling the mine totals, each producing property is requested to report the actual tonnage of lead ores and concentrates shipped, and from this tonnage the lead content is reckoned by assay value. The quantities thus obtained from all the producing properties in each State are combined to make the total. It is clear that by either method the correctness of the totals is dependent upon complete and correct returns from every producing mine and smelter. It is further essential to the correctness of the mine totals that the assay content be correctly estimated.

With equal conditions affecting the mines and the smelters, the stocks in the ore bins of the smelters should run about even from year to year, and the mine and smelter totals, allowance being made in the former for losses in smelting, should show reasonable agreement. As may be seen from the table, however, there are frequent irregularities in the mine-excess column. The causes of these irregularities fall into four categories. The first is lag, by which is meant the time that elapses between the shipment of ore by the mine and the reduction of the ore by the smelter. This is frequently considerable, for ore raised near the end of the year may remain in the stock bins of the smelter until the succeeding year, and, unless balanced by an equivalent lag from the preceding year, will thus lead to an apparent "mine excess." If, through accident, business depression, or otherwise the mines close down, the smelters largely con-

sume their stocks of ore, and the result may be an apparent "smelter excess." The second source of difference is found in error in the mine totals in the arbitrary calculation of metal content from assay. The dry assay in vogue in the Western States gives results uniformly too low. A decision of the United States circuit court (T. D. 21653) recognizes a differential of 1.5 per cent between the dry assay and chemical analysis, and in actual practice the discrepancy is probably even greater than that. Lastly, these totals do not take into account, except in certain of the Western States, the loss in smelting, ranging from 2 to 5 per cent in the treatment of easily reducible ores and reaching 10 per cent or more in the more refractory ores. Wastage running over 20 per cent is allowed by the Treasury Department in smelting in bond foreign lead ores running high in antimony and arsenic. Lag being left out of account, the totals would normally show a mine excess equal to the smelting loss. Any discrepancy that appears in the table may reasonably be ascribed to one or more of these items. In the long run, barring error and allowing for smelting losses and exportation of ore, the "mine excess" will be balanced by equivalent "smelter excess."

By referring to the table comparing the mine and smelter totals, it will be seen that twice during the last 13 years the production of lead by the mines has been less than the output of the smelters. In the other years the mine production has been considerably in excess. The total output of lead in refined lead, antimonial lead, and pigments by the smelters during the 13 years was 5,939,387 tons, and the output of the mines for the same period was 6,287,284 tons, the excess of mine production over smelter production being 347,897 tons.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

World's production of lead by countries where smelted but not necessarily refined, 1913–1919.

[Reduced where necessary to metric tons.]

Country.	1913	1914	1915	1916	1917	1918	1919
Africa:							
Rhodesia	295	136	25	.....	5,028	8,311	10,172
Tunis	(a)	(a)	(a)	(a)	(a)	16,533	(a)
Australia	110,444	101,788	102,721	134,072	144,950	163,368	83,408
Austria-Hungary	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Belgium	103,480	70,980	16,770	15,560	22,745	20,630	53,590
Canada	17,202	16,531	19,740	19,879	20,709	17,005	16,143
France	28,817	29,601	14,539	24,276	21,235	12,778	10,928
Germany:							
Upper Silesia	41,300	36,950	28,750	41,620	32,960	23,960	18,580
Other Germany	139,800	161,500	106,000	(a)	(a)	(a)	(a)
Great Britain	30,990	20,000	16,020	12,980	11,614	11,269	11,458
Greece	18,309	20,684	11,595	9,424	1,422	(a)	3,841
India (Burma)	5,951	10,717	13,738	14,011	17,233	19,380	19,396
Italy	21,674	20,464	21,812	24,362	16,237	18,332	16,530
Japan	3,777	4,562	4,764	11,371	15,807	10,769	5,771
Mexico [b]	41,569	14,853	38,319	13,232	50,212	69,035	54,932
Russia	1,523	1,080	935	540	(a)	(a)	(a)
South America [b]	93	.....	249	137	171	35	.....
Spain	198,829	143,524	171,474	147,407	176,309	169,709	125,721
Sweden	1,235	1,396	1,917	2,076	3,174	2,241	827
Turkey	13,900	(a)	(a)	(a)	(a)	(a)	(a)
United States	385,643	472,126	468,656	506,490	511,942	503,702	391,982
Other countries	(a)	(a)	(a)	(a)	(a)	(a)	(a)

[a] Statistics not available.

[b] In the absence of official Mexican reports of smelter output of lead, or of exports of lead, the imports of Mexican lead into the United States in the form of bullion and pig lead are given. The same holds for South America.

The foregoing statistics of the world's production of lead, though incomplete, give some idea of the foreign production during the World War. The figures in black-faced type are taken from the official statistics of the countries named; those in ordinary type are taken from statistical handbooks, consular reports, market letters, and trade journals. There is always a possibility of duplication in figures showing world production, for some countries send "work lead" or base bullion to other countries for refining. Furthermore, secondary and antimonial lead are included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary lead and antimonial lead. The figures for the United States represent refined lead that was smelted in this country, whatever the source of the ore.

IMPORTS AND EXPORTS.

WAREHOUSE TRANSACTIONS.

Lead imported into the United States as metal or ore may be entered for immediate consumption, the duty being paid and the lead going direct to the consumer; or it may be entered for warehouse, bond being given for double the amount of the estimated duty. In the accompanying tables the phrase "general imports" indicates the total imports, including both lead entered for immediate consumption and lead entered for warehouse. From warehouse the lead may be withdrawn for consumption by payment of duty, or it may remain in bond for smelting and refining, finally being either withdrawn for consumption or exported from warehouse with cancellation of bond. The lead entered for immediate consumption and that withdrawn from warehouse for consumption make up the "imports for consumption," which are expressed in the same terms as those under which they were imported. By-product antimonial lead made by refining lead of foreign origin in bonded smelting warehouse can be withdrawn for consumption as type metal (T. D. 31201). The lead imported for consumption may be actually used in this country, or it may be manufactured into articles which are exported; in the latter event the manufacturer is entitled to the benefit of a drawback of 99 per cent of the duties paid. In the table on page 329, showing foreign lead exported in manufactures with benefit of drawback, the lead is shown in the form in which it was originally imported. On account of diversity of form it is not feasible to show the articles exported with benefit of drawback. The foreign lead given in the table as exported from warehouse is likewise shown in the form in which it was imported and entered for warehouse. Foreign lead exported from warehouse has, since July 1, 1915, been included by the Bureau of Foreign and Domestic Commerce in the domestic exports as "from foreign ore."

The items foreign lead exported from warehouse, domestic exports of lead "from foreign ore," and foreign lead exported in manufactures with benefit of drawback make up the total foreign lead going out of the country. Lead in warehouse and deductions by liquidation being disregarded, the difference between the sum of these exports of foreign lead and the total imports of lead constitutes the foreign lead consumed in this country. For the sake of simplicity

this foreign lead is carried on the bonded customs warehouse records in the form in which the lead was entered until the bond is canceled. It must be clearly understood, therefore, that the lead listed in the table of foreign exports of lead, on a later page, was not exported as lead content of ore and base bullion but as refined lead smelted and refined from them. Since 1914, however, all foreign lead exported has been classed as lead, "pigs and bars," except a portion of the articles manufactured from foreign lead and exported with benefit of drawback. For articles not made wholly of lead it would be useless to give weights, but each shipment on which drawback is claimed is accompanied by a manifest of the imported lead used in making the articles and the duty paid thereon. From these manifests is derived the statement of the total quantity of foreign lead used in manufactures exported with the benefit of drawback. For this reason the lead is given in the form in which it was imported.

The following table is taken from the reports of the Bureau of Foreign and Domestic Commerce. For the reasons given above, the lead is shown in the terms in which it was imported. For instance, a considerable part of the lead stated as remaining in ore and base bullion doubtless represents refined lead waiting at the bonded refinery for a favorable market for shipment. If this is borne in mind, the table gives a fair idea of the fluctuations of foreign stock at different times and in different localities.

Lead remaining in warehouse in the United States, Dec. 31, 1910–1919, in pounds.

Year.	Form in which lead was entered for warehouse.		Remaining at—					
			New York.		Chicago, Ill.	El Paso, Tex.	St. Louis, Mo.[a]	San Francisco, Calif.
	Lead in ore and base bullion.	Pigs, bars, and old.	Newark, N. J.	Perth Amboy, N. J.				
1910	71,794,443	149,082	7,548,936	36,112,136	21,090,631	6,937,667	.....	.....
1911	8,869,713	93,082	2,777,692	2,308,322	954,884	2,555,733	273,082	.....
1912	20,891,182	93,892	1,880,828	17,666,768	484,671	767,533	91,382	.....
1913	10,620,953	.....	8,785,551		80,880	1,683,091	71,431	.....
1914	15,333,064	3,837	10,309,592		94,775	4,802,961	125,736	.....
1915	24,338,933	.....	8,401,728		165,257	14,678,809	104,922	988,217
1916	23,667,358	1,070,298	8,575,115		4,732,535	6,814,844	3,286,189	258,675
1917	47,853,945	5,370,445	19,015,511		4,757,315	18,951,649	2,306,855	2,822,615
1918	33,997,822	944,483	(b)		(b)	(b)	(b)	(b)
1919	90,952,684	468,154	(b)		(b)	(b)	(b)	(b)

[a] Kansas City before 1914. [b] Not available.

IMPORTS.

The following tables are taken from the reports and records of the Bureau of Foreign and Domestic Commerce:

Lead imported and entered for consumption in the United States, 1910–1919.

Year.	Lead in ore.		Base bullion.		Pigs, bars, and old.		Sheets, pipe and shot.		Not otherwise specified.	Total value.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.		
1910	7,998,859	$198,196	16,543,167	$337,223	6,776,066	$212,858	39,779	$1,972	$4,843	$755,092
1911	1,474,254	26,563	17,376,459	352,595	7,112,749	242,423	63,151	2,855	7,218	631,654
1912	935,861	24,760	22,729,467	462,559	5,191,823	110,459	31,184	2,305	5,468	605,551
1913	2,306,972	75,835	17,665,227	388,116	4,621,270	105,738	39,171	3,291	12,710	585,690
1914	5,459,961	188,749	8,904,649	301,195	575,290	12,281	62,552	2,753	81,894	586,872
1915	2,865,792	96,010	15,496,230	519,355	997,368	32,951	201,510	17,059	107,580	772,955
1916	10,125,983	368,824	5,242,171	208,277	6,388,097	331,235	532	63	106,560	1,014,959
1917	5,438,931	207,370	6,965,849	470,539	1,756,223	85,743	12,538	2,699	10,287	776,638
1918	6,064,902	344,080	3,559,071	180,070	1,139,950	56,694	6,892	624	36,723	618,191
1919	4,106,823	196,363	31,796,693	1,130,937	10,174,115	415,094	8,018	628	17,187	1,760,209

Type metal imported and entered for consumption in the United States, 1910–1919.

Year.	Type metal.		Lead content.	
	Gross weight (pounds).	Value.	Quantity (pounds).	Percentage.
1910	13,394,199	$485,493	11,176,830	84.9
1911	8,390,470	310,658	6,936,711	82.7
1912	581,411	18,668	477,006	82.0
1913	567,004	20,098	467,688	82.5
1914	1,509,538	45,373	1,322,188	87.6
1915	2,768,261	107,607	2,424,306	87.6
1916	1,162,386	83,816	923,473	79.4
1917				
1918	551,794	35,938	513,166	93.0
1919	13,394,803	816,642	11,000,498	82.1
Average lead content, 1910–1919				83.3

General imports of lead into the United States, in ore, base bullion, and refined, 1910–1919, by sources, in pounds.

Year.	Canada.	Mexico.	South America.	Europe.	Other countries.	Total imports.
1910	206,979	203,290,307	6,598,263	2,714,796	4,394,421	217,204,766
1911	270,947	172,633,479	4,778,221	569,161	1,651,544	179,903,352
1912	319,497	159,455,664	3,207,936	829,139	3,309,356	167,121,592
1913	338,569	95,693,439	8,766,327	810,019	8,685,612	114,293,966
1914	384,007	46,282,207	2,417,744	4,898,552	2,694,293	56,676,803
1915	2,303,170	94,247,384	5,420,567	217,773	802,516	102,991,410
1916	12,606,216	48,395,670	6,235,758	575,759	2,845,949	70,659,352
1917	11,738,379	125,782,759	4,556,460	8,945,899	5,520,323	156,543,820
1918	28,225,878	162,259,199	1,962,124	62,510	4,705,049	197,214,760
1919	10,391,115	125,541,614	5,504,416	89,840	286,142	141,813,127

General imports of lead into the United States, 1910–1919, by classes, in pounds.

Year.	Lead in ore (lead content).	Base bullion.		Pigs, bars, sheets, and old.	Total lead content.
		Gross weight.	Lead content.		
1910	94,751,054	118,061,415	115,483,542	6,970,170	217,204,766
1911	35,686,180	141,481,852	138,952,372	5,264,800	179,903,352
1912	19,577,499	152,420,624	146,999,168	544,925	167,121,592
1913	19,883,313	96,908,170	94,327,654	82,999	114,293,966
1914	23,649,637	33,444,503	32,730,320	296,846	56,676,803
1915	18,185,140	86,247,995	83,986,988	819,282	102,991,410
1916	35,086,100	24,943,660	24,262,435	11,310,817	70,659,352
1917	41,292,876	109,279,997	103,664,970	11,585,974	156,543,820
1918	37,070,340	155,810,003	149,663,889	10,480,531	197,214,760
1919	19,573,856	115,317,160	112,024,518	10,214,753	141,813,127

Basic carbonate (corroded) white lead, red lead, litharge, and orange mineral, imported and entered for consumption in the United States, 1911–1919.

Year.	Corroded white lead.		Red lead.		Litharge.		Orange mineral.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.		*Pounds.*		*Pounds.*		*Pounds.*	
1911	741,071	$46,213	1,063,533	$42,471	24,662	$1,196	504,734	$28,515
1912	687,705	46,494	757,908	33,854	32,443	1,550	334,551	20,914
1913	672,109	45,266	99,832	4,903	34,023	1,750	330,525	22,205
1914	596,567	40,203	12,554	2,934	33,651	1,805	240,388	16,388
1915	339,157	24,608	1,968	132	20,650	1,422	171,572	14,061
1916	88,617	8,050	20,467	5,302	1,320	150	70,934	8,281
1917	20,238	1,965	50	13	.....	.....	33,294	4,892
1918	508	202	5	1	100	12	.....	.....
1919	21,213	2,490	7,199	1,136	.....	.....	39,781	5,082

EXPORTS.

DOMESTIC EXPORTS.

The average difference between the prices of lead at New York and at London for the 10 years prior to 1914 was not far from 1½ cents a pound and the price at New York was the higher. This being the case, exports of domestic pig lead should be expected only under temporary or very unusual circumstances. The practice of the Bureau of Foreign and Domestic Commerce has been to class all exports of lead articles manufactured in this country as domestic exports, whether the lead is of domestic or foreign origin. For this reason no table of exports of domestic lead manufactures has been given, because such a table would duplicate the table showing foreign lead in manufactures exported with benefit of drawback. Since the exports of domestic pig lead began, however, they have been shown separately.

In 1914 the price of lead at London rose above the price at New York early in January and remained between one-fourth and one-half cent a pound above throughout the year. This made it possible to export domestic lead at a profit, and the decrease in imports of lead

ore and bullion from Mexico rendered it necessary to satisfy the foreign demand with domestic lead, the exports of which assumed large proportions. The movement commenced in March, 1914, and by the end of the year had reached large proportions. Likewise in 1915 the price of lead at London was from one-fourth to 1 cent a pound higher than the price at New York, except for the period of high prices in the United States during June and July, and exports of domestic lead continued heavy throughout the year.

Exports of refined lead from domestic ores reached the maximum both as to quantity and value in 1916. They dropped off almost one-half in 1917, showed a further decline in 1918, and were down to 10,510 tons in 1919.

Refined lead made from domestic ores and exported from the United States, 1914–1919.

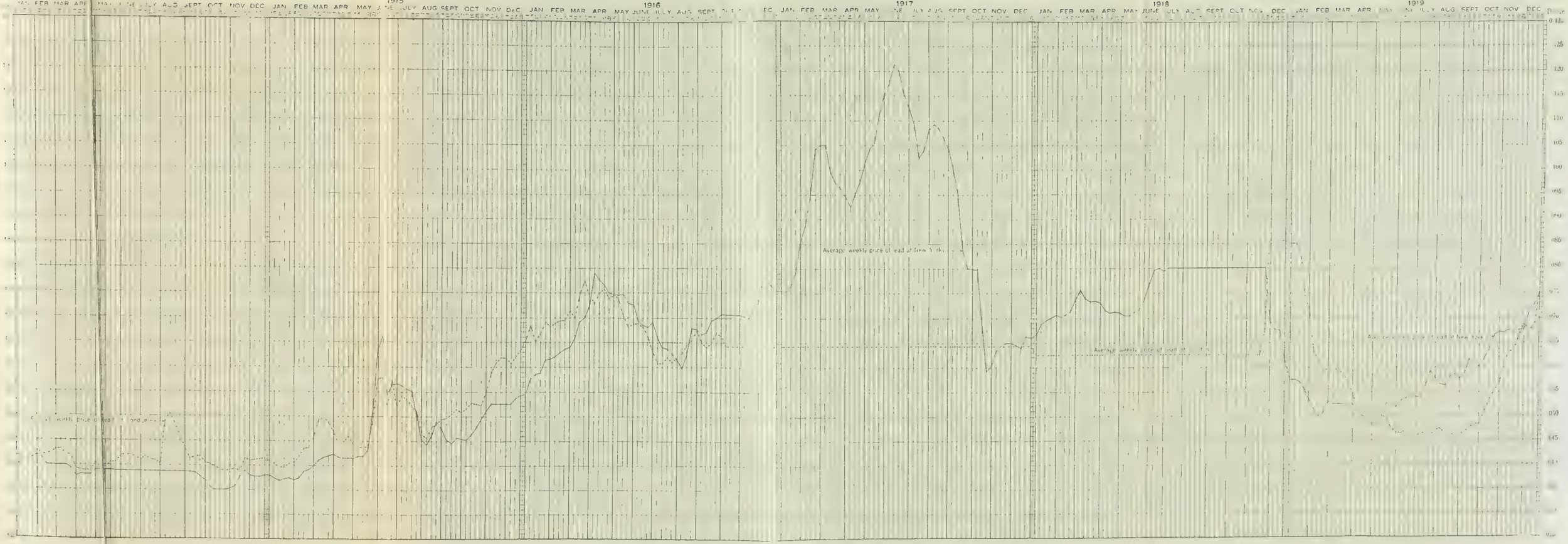
Year.	Quantity (short tons).	Value.
1914	58,722	$4,501,674
1915	88,306	7,928,518
1916	100,500	13,494,065
1917	53,688	9,560,598
1918	41,831	5,889,381
1919	10,510	1,471,256

White lead exported from the United States, 1913–1919.

Year.	Quantity (pounds).	Value.
1913	15,062,384	$905,398
1914	17,645,538	1,017,376
1915	25,310,369	1,409,622
1916	27,435,054	2,137,072
1917	19,737,399	2,089,659
1918	15,588,916	1,756,739
1919	28,033,485	3,037,292

FOREIGN EXPORTS.

By foreign lead exports are meant the exports of lead of foreign origin which has been smelted, refined, or manufactured in this country and then shipped abroad. The following table, made up from the records of the Bureau of Foreign and Domestic Commerce, shows the total lead exported for a period of years; but it must be borne in mind, as pointed out on a previous page, that prior to 1915 the actual exports were not in the form shown in the table, which is the import form, but instead consisted of refined lead and lead manufactures. Since July 1, 1915, the exports of foreign lead heretofore classed as "ore," "base bullion," and "pigs, bars, and old" are all included in "pigs, bars, and old" as domestic manufactures of lead from foreign ore. The quantities given for lead exported from warehouse are exact, but the quantities given for lead in manufactures are subject to the waste in manufacturing.



AVERAGE WEEKLY PRICE OF LEAD AT NEW YORK AND LONDON, 1914-1919.

The London curve for 1919 takes into account the fluctuations in the rate of exchange.

Foreign lead exported from the United States, 1910–1919.

Year.	Exported from warehouse.							Exported in manufactures with benefit of drawback.	
	Lead content of ore.		Lead content of base bullion.		Pigs, bars, and old.		All other manufactures.	Lead content of ore.	Pigs, bars, bullion, and old.
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Value.	Quantity (pounds).	Quantity (pounds).
1910	22,508,090	$248,220	117,045,333	$2,262,057	19,507	$703	$870	6,592,294	11,008,604
1911	39,276,820	730,247	151,986,265	3,093,290	12,311,102	244,037	1,504	674,621	23,485,929
1912	12,796,703	219,859	116,907,305	2,478,256	107,170	3,826	2,121	150,617	22,584,221
1913	11,721,714	271,985	77,253,891	1,827,538	111,506	4,851	3,422	74,628	19,484,345
1914	6,724,525	245,205	10,944,350	378,286	25,421,500	913,306	2,242	4,040,924	14,936,428
1915	(a)	.....	(a)	.....	77,236,303	2,738,263	40,112	7,966,372	
1916	(a)	.....	(a)	.....	19,760,086	1,111,653	541	10,341,075	
1917	(a)	.....	(a)	.....	75,304,480	6,650,157	900	15,074,947	
1918	(a)	.....	(a)	.....	118,832,344	8,309,798	4,347	6,852,173	
1919	(a)	.....	(a)	.....	81,951,396	4,536,273	44	3,872,130	

a Since July 1, 1915, the Bureau of Foreign and Domestic Commerce has classed all foreign lead exported as "domestic exports, of pigs, bars, etc., produced from foreign."

CONSUMPTION.

In statements of consumption of lead in these reports prior to 1907 it was the custom to take into account the smelter stocks of lead at the beginning and at the end of the year. It is not to be denied that for the individual year this gives closer figures. It is just as true that account of trade stocks should also be taken to arrive at accurate results; but this is manifestly outside the scope of the work of this Survey. It was found impossible to obtain a complete statement of stocks after 1906; hence consumption was calculated without reference to domestic stocks. At that time a very considerable part, from one-fourth to one-fifth, of the lead smelted and refined in this country was lead of foreign origin smelted in bond, and it is possible to obtain statistics of the stocks of this part, for they are reported annually by the Bureau of Foreign and Domestic Commerce as "merchandise remaining in warehouse at close of year." For the years 1907 to 1917, inclusive, therefore, "lead available for consumption" was calculated by taking the production from domestic ores and using the total imports and exports of foreign lead in all forms—ore, bullion, and pigs—and likewise the stocks of foreign lead in warehouse at the beginning and end of each year. Though complete statements of stocks of refined lead are still unavailable, the conclusion has been reached that a better idea of consumption may be had by basing the calculation, as was done prior to 1907, on the total production of both domestic and foreign lead and on the transactions in refined lead, disregarding altogether the refinery stocks. The "apparent consumption" calculated in this way is given in the table below for the years of the war, together with the average for the four years just prior to the war.

Apparent consumption of refined primary lead in the United States, refinery stocks disregarded, in short tons.

	1910-1913 average.	1914	1915	1916	1917	1918	1919
Supply:							
Stock in bonded warehouses, Jan. 1.	79	.....	2	.....	535	2,685	472
Imports of pigs, bars, and old	1,608	148	410	5,655	5,793	5,240	5,107
Production	475,151	542,122	550,055	571,134	610,769	640,195	482,220
	476,838	542,270	550,467	576,789	617,097	648,120	487,799
Withdrawn:							
Exports of foreign lead:							
From warehouse	70,256	21,545	38,618	9,880	37,652	59,416	40,976
In manufactures, with benefit of drawback	10,505	9,489	3,983	5,171	7,537	3,426	1,936
Exports of domestic lead	.....	58,722	88,306	100,500	53,688	41,831	10,510
Stock in bonded warehouses, Dec. 31	.....	2	.....	535	2,685	472	234
	80,761	89,758	130,907	116,086	101,562	105,145	53,656
Apparent consumption	396,077	452,512	419,560	460,703	515,535	542,975	434,143

PRICES AND VALUE.

At the beginning of 1919 lead was quoted on the New York market at 5.75 cents, but it went slightly below 5 cents in April and May, after which it steadily climbed until the close of the year, when it was quoted at 7.5 cents. The average of quotations for immediate delivery at New York in 1919 was 5.8 cents a pound. The average price, as figured from the total sales during the year, was 5.3 cents a pound, as compared with 7.1 cents a pound in 1918. These are the figures used in calculating the value of the lead produced from domestic ores in the United States in those years.

Prices quoted on lead by the American Smelting & Refining Co. in 1919, in cents a pound.

January 21	5.50	July 18	5.75
January 31	5.25	July 24	6.00
February 7	5.00	September 15	6.25
February 20	5.10	October 16	6.50
February 25	5.25	October 23	6.75
April 9	5.00	December 3	6.90
May 16	5.10	December 12	7.00
May 19	5.25	December 18	7.15
June 11	5.40	December 26	7.50
July 14	5.50		

The London price of lead for prompt shipment was £40 per long ton (8.5 cents a pound) at the beginning of the year but it rapidly fell from this level to £22 a long ton (4.59 cents a pound) by June 25. After remaining comparatively stationary for three months the price began to rise and reached £45 10s. a long ton (7.76 cents a pound) at the end of the year. Although the price per ton in pounds sterling was higher at the end of the year than at the beginning, the actual value in cents per pound was lower at the end of the year, owing to the depreciation of exchange rates. Through the first third of the year the London price was much above the St. Louis price, but for the remainder of the year it was considerably below.

The fluctuations in the price of lead at New York and London are graphically shown in Plate III, which gives curves of the average weekly price of lead in those markets for the years 1914 to 1919, inclusive.

As stated on page 313, the value of the output of refined lead in the United States from domestic ores in 1919 was $44,990,000, at the average price of refined lead, as compared with $76,667,000, based on the average price in 1918, a loss of $31,677,000, or 41 per cent.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN ARIZONA.[1]

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

The mines of Arizona produced in 1919 ore and placer bullion containing gold, silver, copper, lead, and recoverable zinc valued at $111,157,872. The value of the output, compared with that of 1918, decreased about 45 per cent. There were 324 producers from deep mines and 15 producers from placers, as against 456 deep-mine and 13 placer producers in 1918. There was a decrease in the quantity and value of all the metals, but particularly in copper. Dividends paid in 1919 by 13 companies amounted to $21,420,888. The Phelps Dodge Corporation, owning mines in Mexico, New Mexico, and Arizona, paid dividends amounting to $6,975,000 during 1919. This was not included in the State total, as the amount derived from the operations of its properties at Morenci and Bisbee was not reported separately.

Mine production of gold, silver, copper, lead, and recoverable zinc in Arizona in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	469	19,038,486	$5,435,027	6,686,152	764,855,874	12,503,689	2,269,643	$202,134,880
1919	339	13,727,403	4,506,413	5,266,605	538,100,844	10,203,078	1,717,000	111,157,872
Decrease, 1919	130	5,311,083	928,614	1,419,547	226,755,030	2,300,611	552,643	90,977,008

[a] Includes small placer production.

ORE.

Ores produced from mines in Arizona in 1919 aggregated 5,311,083 short tons less than in 1918. The total average value per ton decreased from $10.62 in 1918 to $8.10 in 1919, but the gold and silver value per ton increased from 64 to 76 cents. The dry or

[1] Valuable assistance in the preparation of the report and the compilation of statistical tables was rendered by Bessie N. Patchell, of the United States Geological Survey.

siliceous ores, principally from Mohave and Cochise counties, decreased only slightly. The 190,069 tons of siliceous gold ore averaged $13.62 in gold and 0.39 ounce of silver to the ton. The 85,070 tons of siliceous silver ores averaged per ton $1.04 in gold, 9.52 ounces of silver, and a little copper and lead. Of this ore, 78,150 tons was produced in the Turquoise and Tombstone districts of Cochise County.

The copper ore mined by 150 producers aggregated 13,347,182 tons, against 18,647,039 tons mined by 234 producers in 1918. The larger part of the copper ore mined, or 9,119,999 tons, came from low-grade disseminated deposits near Globe, Ray, and Ajo, where most of the ore was treated. The richer siliceous ore, or that valuable as converter lining, was shipped to smelters. Similar disseminated ore amounting to 1,299,330 tons was mined and milled from the low-grade copper deposits in the Clifton and Morenci camps of Greenlee County. Altogether the output of disseminated ores aggregated 10,419,329 tons and yielded 264,262,320 pounds of copper, or more than 49 per cent of the total output of the State. The crude copper ores mined and smelted directly (without previous concentration) amounted to 2,263,761 tons, averaging 58 cents in gold and 1.30 ounces of silver per ton and 5.40 per cent of copper, with an average value of $22.11 a ton, against 3,773,935 tons in 1918, with an average value of $27.42 a ton. Of the copper ores smelted directly, 1,623,584 tons were sulphides, averaging 69 cents in gold and 1.50 ounces of silver per ton, and 5.45 per cent of copper, and having an average value of $22.63 a ton. The oxidized copper ore smelted, 640,177 tons, contained 32 cents in gold and 0.79 ounce of silver per ton and 5.27 per cent of copper, and was valued at $20.81 a ton. There was a decrease in the quantity of lead ore smelted from 19,873 tons in 1918 to 9,414 tons in 1919. Of this ore, 6,775 tons was oxidized and 2,639 tons was sulphide ore. The oxidized ores contained $2.37 in gold and 19.38 ounces of silver per ton, 0.47 per cent of copper, and 21.94 per cent of lead and had a total average value of $49.06 a ton. The sulphide lead ores contained $5.69 in gold and 28.73 ounces of silver per ton, 0.64 per cent of copper, and 19.15 per cent of lead. The quantity of zinc ores mined decreased from 2,129 tons in 1918 to 2,038 tons in 1919. The zinc ore was of smelting grade and was all sulphide. No lead-zinc ore was produced in 1919, but the copper-lead ore, most of which was concentrated, amounted to 7,261 tons in quantity.

Ore and metals produced in Arizona in 1919.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds*
Placers	15	.....	227.07	36	.....	.....	.....
Dry or siliceous ore	103	294,675	135,941.83	1,031,185	731,813	45,642	.....
Copper ore	150	13,347,182	78,103.32	3,711,052	537,201,237	179	.....
Lead ore	78	76,247	3,701.41	441,739	137,546	10,088,794	.....
Zinc ore	1	2,038	.....	.....	.....	.....	1,717,000
Copper-lead ore	6	7,261	24.09	82,593	30,248	68,463	.....
	.....	13,727,403	217,997.72	5,266,605	538,100,844	10,203,078	1,717,000

Ore sold or treated in Arizona in 1919, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Total.
Cochise	80,468	1,247,455	49,283	.....	1	1,377,207
Coconino	.....	103	.....	.....	.....	103
Gila	466	6,373,463	295	.....	16	6,374,240
Graham	.....	9	2,447	.....	.....	2,456
Greenlee	926	1,300,273	.....	.....	.....	1,301,199
Maricopa	.....	99	58	.....	.....	157
Mohave	188,263	7,578	5,199	.....	.....	201,040
Pima	72	1,651,267	985	.....	.....	1,652,324
Pinal	.....	2,018,141	4,227	.....	7,158	2,029,526
Santa Cruz	2,692	18,308	3,715	.....	86	24,801
Yavapai	21,723	712,533	1,927	2,038	.....	738,221
Yuma	65	17,953	8,111	.....	.....	26,129
	[a] 294,675	13,347,182	76,247	2,038	7,261	13,727,403
Value per ton in gold and silver	$13.45	$0.43	$7.49	.....	$12.81	$0.76

[a] Includes 190,069 tons of gold ore, 19,536 tons of gold and silver ore, and 85,070 tons of silver ore.

GOLD.

Arizona ores, placer dust, and bullion yielded gold valued at $4,506,413 in 1919. Of this value, $4,694, against $4,234 in 1918, came from placers; $2,810,167, against $3,100,767 in 1918, came from dry or siliceous ore; and $1,614,539, against $2,248,071 in 1918, came from copper ores. The mines in Mohave County produced the largest output of gold—$2,582,331 in 1919, against $2,798,903 in 1918. Cochise County was second, with a production of $940,538, against $1,108,685 in 1918. Gold recovered from ores treated in gold and silver mills represented more than 57 per cent of the total production, and gold in crude ores shipped to smelters more than 34 per cent. From ores treated in mills by amalgamation the gold recovered amounted to $6,588, and that from ores treated by cyanidation to $2,576,233. Concentrates contained $350,678, against $419,589 in 1918, and ores shipped directly to smelters contained $1,544,812, against $2,091,292 in 1918. The chief producing districts in 1919 were the San Francisco district, in Mohave County, where siliceous gold ores were produced; the Warren district, in Cochise County, where copper ores were produced; and the Verde district, in Yavapai County, where both siliceous and copper ores were produced.

Of the mines producing in 1919 the United Eastern, at Oatman, was first, with 91,263.80 ounces from siliceous ore. The Tom Reed mine, at Oatman, was second, followed by the Calumet & Arizona, at Bisbee, the United Verde, at Jerome, the Copper Queen, at Bisbee, the Blue Bell, in Yavapai County, and the Magma, in Pinal County. Altogether these seven properties yielded more than 86 per cent of the total gold.

Mine production of gold in Arizona in 1919, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Cochise	60.86	4,516.72	38,520.48	2,400.40	0.07	45,498.53
Coconino			.43			.43
Gila		61.14	7,727.93	111.10		7,900.17
Graham				2.80		2.80
Greenlee		264.77	3,121.58			3,386.35
Maricopa	18.77		17.41			36.18
Mohave		124,198.99	18.53	702.74		124,920.26
Pima		13.10	12.89	44.01		70.00
Pinal			5,159.58	241.71	21.21	5,422.50
Santa Cruz		41.00	19.20	105.19	2.81	168.20
Yavapai	100.76	6,765.88	22,796.73	85.71		29,749.08
Yuma	46.68	80.23	708.56	7.75		843.22
	227.07	[a] 135,941.83	78,103.32	3,701.41	24.09	217,997.72

[a] Includes 125,188.13 ounces from gold ore, 6,474.19 ounces from gold and silver ore, and 4,279.51 ounces from silver ore.

SILVER.

Silver produced from mines in Arizona decreased from 6,686,152 ounces in 1918 to 5,266,605 ounces in 1919 and in value from $6,686,152 to $5,898,598. Of this output 3,711,052 ounces came from copper ore, 1,031,185 ounces from dry or siliceous ore, 441,739 ounces from lead ore, and 82,593 ounces from copper-lead ore. Cochise and Mohave counties were the only ones in which there was an increase in the production of silver. Bullion recovered from gold and silver ores, largely by cyanidation, yielded 117,641 ounces of silver in 1919. Concentrates contained 1,085,082 ounces, and crude ore shipped to smelters contained 3,971,687 ounces, representing more than 75 per cent of the total output. Cochise County mines led in output of silver, producing 2,421,905 ounces in 1919, against 2,315,518 ounces in 1918, and Yavapai County produced 1,252,894 ounces in 1919, against 2,502,968 ounces in 1918 and 2,207,583 ounces in 1917.

More than 57 per cent of the total silver came from the ore of five copper properties—the Calumet & Arizona, at Bisbee; the United Verde, at Jerome; the Copper Queen, at Bisbee; the Magma, in Pinal County; and the Bunker Hill, in Cochise County.

Mine production of silver in Arizona in 1919, in fine ounces.

County.	Placers	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Cochise	8	626,645	1,593,094	202,144	14	2,421,905
Coconino			664			664
Gila		15,214	421,024	3,230	179	439,647
Graham			91	16,229		16,320
Greenlee		18,525	87,716			106,241
Maricopa	2		39	338		379
Mohave		88,245	4,770	71,502		164,517
Pima		1,731	25,645	13,279		40,655
Pinal			504,019	7,692	80,820	592,531
Santa Cruz		77,695	60,166	83,800	1,580	223,241
Yavapai	16	203,106	1,013,022	36,750		1,252,894
Yuma	10	24	802	6,775		7,611
	36	[a] 1,031,185	3,711,052	441,739	82,593	5,266,605

[a] Includes 73,951 ounces from gold ore, 147,712 ounces from gold and silver ore, and 809,522 ounces from silver ore.

COPPER.

The mine production of copper in Arizona in 1919—538,100,844 pounds, valued at $100,086,757—was a decrease of 226,755,030 pounds in quantity and of $88,832,644 in value from the production in 1918. Crude ore shipped directly to the smelters yielded 245,073,392 pounds, or more than 45 per cent of the total quantity, against 394,382,678 pounds in 1918. Of the output from crude ore smelted in 1919, Cochise County produced more than 51 per cent. Yavapai, Gila, Pima, Greenlee, and Pinal counties also produced large quantities of copper. The copper in concentrates produced at milling plants decreased from 325,058,915 pounds in 1918 to 255,613,241 pounds in 1919. This decrease was made largely in Gila, Pinal, and Greenlee counties. Gila County, including the Globe and Miami districts, produced altogether 154,491,616 pounds of copper in concentrates, against 173,897,683 pounds in 1918. The low-grade disseminated ores in Pima, Pinal, and Gila counties yielded 219,539,871 pounds of copper, against 280,202,381 pounds in 1918. Similar low-grade copper deposits exist in Greenlee County, whose output added made the total production from the disseminated deposits in Arizona 264,262,320 pounds, or more than 49 per cent of the aggregate output in 1919. In 1918 these ores altogether produced 331,696,434 pounds of copper.

Twelve properties produced about 90 per cent of the total quantity of copper, each of them yielding more than 10,000,000 pounds. The Inspiration, in Gila County, was first, with 78,038,306 pounds, followed by the Copper Queen, in Cochise County, 68,614,002 pounds; the Miami, in Gila County, 55,610,864 pounds; and the Calumet & Arizona, in Cochise County, 44,991,107 pounds. The other mines were the Ray Consolidated, United Verde, New Cornelia, Arizona Copper, United Verde Extension, Old Dominion, Detroit Copper, and Magma.

Mine production of copper in Arizona in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Cochise	283,481	126,181,842	18,466	134	126,483,923
Coconino	.....	32,507	.....	.....	32,507
Gila	7,524	176,518,676	689	1,092	176,527,981
Graham	.....	2,887	43,498	.....	46,385
Greenlee	139	44,867,504	.....	.....	44,867,643
Maricopa	.....	19,924	.....	.....	19,924
Mohave	2,135	296,995	3,537	.....	302,667
Pima	.....	43,795,939	12,552	.....	43,808,491
Pinal	.....	63,649,661	6,261	20,697	63,676,619
Santa Cruz	12,388	1,125,628	46,315	8,325	1,192,656
Yavapai	426,146	79,796,569	4,834	.....	80,227,549
Yuma	.....	913,105	1,394	.....	914,499
	[a] 731,813	537,201,237	137,546	30,248	538,100,844

[a] Includes 1,850 pounds from gold ore, 422,239 pounds from gold and silver ore, and 307,724 pounds from silver ore.

LEAD.

The mine production of lead in Arizona in 1919—10,203,078 pounds, valued at $540,763—was a decrease from 1918 of 2,300,611 pounds in quantity and $346,999 in value. Cochise County, prin-

cipally the Warren or Bisbee district, had the largest yield of lead, or 4,851,238 pounds, valued at $257,116, as against 4,310,288 pounds, valued at $306,030, in 1918. Pinal County followed with 1,314,836 pounds; Santa Cruz County, 1,078,228 pounds; and Mohave County, 916,818 pounds. Concentrates derived from low-grade ores produced 6,130,145 pounds of lead, and crude ores shipped directly to smelters produced 4,072,933 pounds.

Three mines in Arizona produced more than 60 per cent of the total output of lead in 1919, and each of them produced more than 600,000 pounds of lead; they were the Shattuck mine, at Bisbee, the Ray Silver Lead mine, near Ray, and the Grand Reef mine, in Graham County.

Mine production of lead in Arizona in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Cochise	14,908	.....	4,836,092	328	4,851,238
Gila	1,793	.....	90,089	2,644	94,526
Graham	.....	.....	670,814	.....	670,814
Greenlee	1,294	.....	.....	.....	1,294
Maricopa	.....	.....	65,060	.....	65,060
Mohave	500	.....	916,318	.....	916,818
Pima	2,934	.....	486,952	.....	489,886
Pinal	.....	.....	1,265,708	49,128	1,314,836
Santa Cruz	20,234	179	1,041,452	16,363	1,078,228
Yavapai	3,979	.....	233,626	.....	237,605
Yuma	.....	.....	482,773	.....	482,773
	[a] 45,642	179	10,088,794	68,463	10,203,078

[a] Includes 1,460 pounds from gold ore and 44,182 pounds from silver ore.

ZINC.

The mine output of recoverable zinc from Arizona zinc-bearing ores in 1919 amounted to 1,717,000 pounds, valued at $125,341, against 2,269,643 pounds, valued at $206,538, in 1918. The Arizona Hillside property, in Yavapai County, was the only producer of zinc, and all the zinc was from first-class or shipping ore.

MINING INDUSTRY.

During 1919 Arizona was comparatively free from labor disturbances, except for unimportant strikes at Jerome and Oatman, both of which were called by the I. W. W. In general the labor supply was fair, though efficiency was low. The condition of the copper market made it difficult for any except the large operators to engage in other than exploratory and development work. Many silver companies found encouragement in reopening their properties. The gold producers continued mining under the same conditions of high costs as during the war, with possibly a little better supply of labor. Exemption from assessment work on mining claims in 1919 tended to ease the general situation. At the close of 1919 Arizona mining operators generally were looking toward a general shrinkage of copper production, as none of the larger copper companies were operating at capacity, although managers were disinclined to shut down the mines

or even to turn off any considerable number of their workmen, fearing disorganization when the men should be needed.

Ten smelting plants, all treating copper ores, were in operation in 1919, the Copper Queen and Calumet & Arizona, at Douglas; American Smelting & Refining Co., at Hayden; Consolidated Arizona, at Humboldt; International, at Miami; Old Dominion, at Globe; Detroit, at Morenci; Arizona Copper, at Clifton; United Verde, at Clarkdale; and United Verde Extension, at Clemenceau. The Calumet & Arizona smelter, at Douglas, discontinued the use of blast furnaces in 1919 and put all its ores through reverberatories. This change was made because the bulk of the ore mined by the Calumet & Arizona is sulphide. At Morenci the Detroit smelter was closed during the last half of the year. The holdings of the Shannon Copper Co., including the smelter at Clifton, were bought by the Arizona Copper Co. The United Verde and United Verde Extension companies took advantage of the labor strike in the Verde district to overhaul their smelting plants, which closed February 13 and did not resume until May and June. The Arizona Smelting & Power Co. overhauled the never-used copper smelter, comprising a 250-ton furnace, at Benson. The company expects to buy copper ores and get its supply from Johnson, Patagonia, Helvetia, and other districts.

REDUCTION MILLS.

Forty-five milling plants of various kinds were in operation in Arizona in 1919, but only a few continuously. Two mills used straight amalgamation; 4, amalgamation and concentration; 7, only cyanidation; 1, cyanidation and concentration; 31, concentration, of which 7 were equipped for table concentration only, 17 for table and flotation concentration, 5 for straight flotation only, and 2 for dry concentration. In addition there were 2 leaching plants in which copper is recovered by the use of sulphuric acid and electrolytic deposition. A list giving all the mills in commission, including many new plants under construction in 1911 and 1912, was published in Mineral Resources for 1911, Part I, page 426, and for the year 1917 in Mineral Resources for 1917, Part I, pages 549–556.

The ore treated in 1919 by amalgamation amounted to 2,374 tons and gave an average recovery per ton of $2.78 in gold and 0.05 ounce of silver. Ores treated by cyanidation amounted to 191,086 tons, which, with 20,113 tons of old tailings, gave an average recovery per ton of $12.20 in gold and 0.56 ounce of silver. The total value of the bullion recovered from ore and tailings was $2,714,579, as against $3,073,999 in 1918. During 1919 milling plants consumed 117,489 pounds of sodium and potassium cyanide, or 0.49 pound per ounce of gold and silver and 0.56 pound per ton of ore and tailings treated.

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Gold and silver produced at mills in Arizona in 1919.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Cochise	[a] 5,309	79.22	41	[b] 612.65	[b] 43,771	$63,372
Gila	3	57.35	11	.....	.....	1,198
Mohave	187,603	43.71	10	123,891.15	73,439	2,644,224
Yavapai	[c] 495	94.37	29	121.45	320	4,852
Yuma	50	44.07	20	.....	.....	933
	193,460	318.72	111	124,625.25	117,530	2,714,579

[a] Also yielded 40 tons of concentrates.
[b] Includes bullion from 20,113 tons of old tailings.
[c] Also yielded 63 tons of concentrates.

Concentration plants reduced 9,596,953 tons of ore to 641,649 tons of concentrates, which were shipped to smelters and produced $350,678 in gold, 1,085,082 ounces of silver, 255,613,241 pounds of copper (or more than 47 per cent of the total output of copper in the State), and 6,130,145 pounds of lead, valued in all at $49,434,931, a total average value per ton of $77.04. Copper concentrates amounting to 631,437 tons comprised more than 98 per cent of the total concentrates produced.

Mine production of metals from Arizona concentrates in 1919.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.	Gold.	Silver.	Copper.	Lead.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces*	*Pounds.*	*Pounds.*	
Cochise	58,119	10,385	2,407.92	164,176	383,870	4,432,655	$539,984
Gila	6,132,833	299,635	4,760.79	260,509	154,491,616	.....	29,125,625
Graham	2,168	542	1.00	10,487	27,270	450,532	40,716
Greenlee	1,232,971	134,993	2,424.17	67,759	36,784,452	.....	6,967,910
Mohave	10,145	596	88.10	37,733	34,357	399,507	71,647
Pima	14,005	993	7.10	4,207	371,474	53,323	76,779
Pinal	2,006,902	156,906	3,796.60	429,990	58,303,604	96,005	11,409,630
Santa Cruz	10,963	966	.....	2,578	260,625	143,989	58,995
Yavapai	110,701	35,181	3,476.03	101,152	4,468,283	99,495	1,021,520
Yuma	18,146	1,452	2.36	6,491	487,690	454,639	122,125
	9,596,953	641,649	16,964.07	1,085,082	255,613,241	6,130,145	49,434,931

By kinds of concentrates.

Dry or siliceous	.....	88	448.11	1,735	142	.....	$11,232
Copper	.....	631,437	14,303.53	768,804	255,558,612	.....	48,690,643
Lead	.....	10,048	2,199.23	234,660	40,762	6,105,469	639,453
Copper-lead	.....	76	13.20	79,883	13,725	24,676	93,603

Of the material smelted, the crude ore was the largest part—2,334,410 tons. It contained the following quantities of recoverable metals: 74,730.24 ounces, or $1,544,813 in gold, 3,971,687 ounces of silver, 245,073,392 pounds of copper, 4,072,933 pounds of lead, and 1,717,000 pounds of zinc, valued in all at $51,917,959, or an average of $22.24 a ton. The copper ores constituted the largest part of the crude ores smelted, aggregating 2,263,761 tons, of which the Warren

or Bisbee district, in Cochise County, produced more than 53 per cent. The dry or siliceous ores formed the next largest quantity—59,042 tons, followed by lead ores—9,414 tons.

Mine production of metals from Arizona crude ore shipped to smelters in 1919.

By counties.

County.	Crude ore to smelter.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cochise	1,272,776	42,081.93	2,140,636	125,616,288	418,583	.....	$26,654,238
Coconino	103	.43	664	32,507	.....	.....	6,799
Gila	241,404	3,082.04	179,127	22,036,365	94,526	.....	4,368,108
Graham	288	1.80	5,833	19,115	220,282	.....	21,800
Greenlee	56,266	962.16	38,482	7,366,643	1,294	.....	1,433,254
Maricopa	157	17.39	377	19,924	65,060	.....	7,936
Mohave	2,371	895.67	51,648	187,874	517,311	.....	138,721
Pima	95,786	62.90	36,448	7,427,854	436,563	.....	1,446,841
Pinal	22,624	1,625.92	162,541	5,373,015	1,218,831	.....	1,279,636
Santa Cruz	13,408	168.20	218,540	916,869	934,239	.....	468,295
Yavapai	624,294	25,081.68	1,136,301	75,650,129	138,110	1,717,000	15,994,727
Yuma	4,933	750.12	1,090	426,809	28,134	.....	97,604
	2,334,410	74,730.24	3,971,687	245,073,392	4,072,933	1,717,000	51,917,959
By kinds of ore.							
Dry or siliceous	59,042	9,418.40	822,130	602,833	45,642	.....	$1,230,028
Copper	2,263,761	63,798.79	2,939,768	244,357,252	179	.....	50,061,837
Lead	9,414	1,502.19	207,079	96,784	3,983,325	.....	492,099
Zinc	2,038	.....	.....	.....	.....	1,717,000	125,341
Copper-lead	155	10.86	2,710	16,523	43,787	.....	8,654

PRODUCTION BY COUNTIES.

GENERAL STATEMENT.

The following tables show the State output by counties in 1919, the production of each metal, and the total value; also the production of ore and the average value per ton, by counties in 1918 and 1919. The tables are followed by a review of the mining industry of each county and each producing mining district.

Ore sold or treated, number of deep mines producing, and average value of ore per ton in Arizona in 1918 and 1919.

County.	Ore sold or treated, 1919.		Number of deep mines producing.		Average total value per ton.[a]		Average value per ton in gold and silver.[a]	
	Quantity.	Increase or decrease.	1918	1919	1918	1919	1918	1919
	Short tons.	*Short tons.*						
Cochise	1,377,207	− 445,623	53	38	$25.01	$19.92	$1.88	$2.65
Coconino	103	− 56	4	2	80.01	66.01	5.38	7.31
Gila	6,374,240	−1,433,474	45	46	6.65	5.25	.08	.10
Graham	2,456	+ 831	7	4	84.29	25.45	17.60	7.46
Greenlee	1,301,199	− 801,526	22	14	8.55	6.56	.11	.14
Maricopa	157	− 160	7	5	51.28	50.55	9.62	4.98
Mohave	201,040	+ 8,455	60	40	16.07	14.28	15.13	13.76
Pima	1,652,324	− 381,126	54	29	7.39	4.97	.06	.03
Pinal	2,029,526	−1,607,593	33	28	7.00	6.25	.23	.38
Santa Cruz	24,801	− 79,394	41	23	17.41	21.47	2.69	10.22
Yavapai	738,221	− 563,607	88	74	31.07	23.13	2.78	2.73
Yuma	26,129	− 7,810	43	21	18.71	8.44	1.09	.96
	13,727,403	−5,311,083	456	324	10.62	8.10	.64	.76

[a] Placer product excluded.

Mine production of gold, silver, copper, lead, and zinc in Arizona in 1919.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.		
	Quantity.	Value.	Quantity.	Value.		Quantity.	Value.
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Cochise	60.86	$1,258	45,437.67	$939,280	$940,538	2,421,905	$2,712,534
Coconino			.43	9	9	664	744
Gila			7,900.17	163,311	163,311	439,647	492,405
Graham			2.80	58	58	16,320	18,278
Greenlee			3,386.35	70,002	70,002	106,241	118,990
Maricopa	18.77	388	17.41	360	748	379	424
Mohave			124,920.26	2,582,331	2,582,331	164,517	184,259
Pima			70.00	1,447	1,447	40,655	45,534
Pinal			5,422.50	112,093	112,093	592,531	663,635
Santa Cruz			168.20	3,477	3,477	223,241	250,030
Yavapai	100.76	2,083	29,648.32	612,885	614,968	1,252,894	1,403,241
Yuma	46.68	965	796.54	16,466	17,431	7,611	8,524
	227.07	4,694	217,770.65	4,501,719	4,506,413	5,266,605	5,898,598

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Cochise	126,483,923	$23,526,010	4,851,238	$257,116			$27,436,198
Coconino	32,507	6,046					6,799
Gila	176,527,981	32,834,204	94,526	5,010			33,494,930
Graham	46,385	8,628	670,814	35,553			62,517
Greenlee	44,867,643	8,345,382	1,294	69			8,534,443
Maricopa	19,924	3,706	65,060	3,448			8,326
Mohave	302,667	56,296	916,818	48,591			2,871,477
Pima	43,808,491	8,148,379	489,886	25,964			8,221,324
Pinal	63,676,619	11,843,851	1,314,836	69,686			12,689,265
Santa Cruz	1,192,656	221,834	1,078,228	57,146			532,487
Yavapai	80,227,549	14,922,324	237,605	12,593	1,717,000	$125,341	17,078,467
Yuma	914,499	170,097	482,773	25,587			221,639
	538,100,844	100,086,757	10,203,078	540,763	1,717,000	125,341	111,157,872

COCHISE COUNTY.

Mine production in Cochise County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	52	1,822,830	$1,108,685	2,315,518	169,418,920	4,310,288	139,878	$45,589,435
1919	43	1,377,207	[a] 940,538	[a] 2,421,905	126,483,923	4,851,238		27,436,198
Increase or decrease, 1919	−9	−445,623	−168,147	+106,387	−42,934,997	+540,950	−139,878	−18,153,237

[a] Includes placer production.

The total average value per ton of the ore in Cochise County decreased from $25.01 in 1918 to $19.92 in 1919, but the gold and silver value in this ore increased from $1.88 to $2.65. The metals, except silver and lead, decreased in quantity. The value of the silver increased from $2,315,518 in 1918 to $2,712,534 in 1919. Gold decreased

from $1,108,685 in 1918 to $940,538 in 1919; copper, from $41,846,473 in 1918 to $23,526,010 in 1919; lead, from $306,030 in 1918 to $257,116. No zinc was reported in 1919. Ores of smelting grade, of which there were 1,272,776 tons, predominated and contained $869,911 in gold, 2,140,636 ounces of silver, 125,616,288 pounds of copper, and 418,583 pounds of lead, valued in all at $26,654,238, or an average of $20.94 a ton. Of the ores smelted there were 1,235,050 tons classified as copper ore, of which 483,612 tons were estimated to be oxidized ores and 751,438 tons sulphide ores. All the lead ores smelted, 1,659 tons in quantity, were shipped to plants outside of the State and contained 387.18 ounces of gold, 42,066 ounces of silver, 11,334 pounds of copper and 403,347 pounds of lead. All this ore was oxidized. The placer output amounted to $1,258 in gold and 8 ounces of silver.

California (Paradise) district.—There was some development of the mining properties of the district, but only one small shipment of copper ore from the Homestake property was reported. The Hilltop mine was opened during 1919 by the driving of a third adit from the Paradise side of the Chiricahua Mountains to develop the silver-lead ore bodies cut in the two upper tunnels. It is reported [2] that the ore bodies found in the upper tunnel were cut in the second tunnel at a vertical depth of approximately 1,400 feet.

Cochise district (Johnson and Dragoon).—Six producers in the Cochise district in 1919 reported 14,565 tons of ore, containing 1.07 ounces of gold, 12,091 ounces of silver, 1,332,496 pounds of copper, and 4,976 pounds of lead, valued in all at $261,672, or an average of $17.97 a ton. Included in this output was 2,468 tons of concentrating ore containing copper and silver. Most of the ore shipped directly to the smelters was a sulphide copper ore from the Republic group. Lessees at the Copper Chief group produced some oxidized copper ores containing a little silver. There was also a little oxidized copper ore shipped from the Peabody and Centurion claims. The Arizona Middlemarch property, whose output is included in this district, produced milling ore containing copper, which was shipped as concentrate to a Douglas smelter. The Middlemarch mine, which is 9 miles west of Pearce, in the Dragoon Mountains, is one of the old copper mines of Arizona and was first operated about 20 years ago by Richard Gird and others. They built a small water-jacket furnace and made black copper from the oxidized ore of the Missouri claim, but when the low-grade sulphide ore was encountered at shallow depth smelting was discontinued. Later a small concentrating plant was installed to treat the sulphide ore, but owing to the high specific gravity of the gangue (mainly garnet and epidote) and the tendency of the copper minerals to float, this mill proved a failure. The extraction was low and the concentrate was contaminated with the heavy gangue minerals. Later an attempt was made to operate the property by shipping the crude ore, and about 70 carloads of ore were shipped to the smelters at Douglas, for the most part at a loss. The geology of the region and the character and occurrence of the ore, together with a description of the mine and the mill, are given in a recent paper.[3]

[2] Min. and Sci. Press., vol. 118, p. 239, Aug. 16, 1919.
[3] Snyder, B. M. The Middlemarch mine and mill: Min. and Sci. Press, vol. 118, pp. 181–182, Feb. 8, 1919.

Dos Cabezas district.—Three mines shipped 2,159 tons of ore, containing 673.22 ounces of gold, 559 ounces of silver, 972 pounds of copper, and 1,460 pounds of lead, valued in all at $14,801, or an average of $6.86 a ton. The principal output came from the Gold Prince property, which yielded gold ore treated in a 25-ton Huntington mill. Shipments consisted of gold bullion and concentrate. There was also a little ore, containing principally gold with some lead, copper, and silver, shipped from the Dives group. Extensive development work was carried on at the Mascot group, which has been equipped with a 50-ton experimental plant using concentration, and during its operation some copper concentrate was produced but not shipped.

Hartford or Huachuca district (Hereford and Garces).—The placer operations near Garces produced a little gold. These placers are in the vicinity of mineral veins containing tungsten, and some scheelite has been recovered from the placer gravels in addition to the gold. It was reported that a nugget of gold weighing 8½ ounces was recently found in the Old Timer placer in Ash Canyon, where about 50 ounces of gold were recovered during the year. From one property in the district a small quantity of ore containing principally lead and a little copper and silver was shipped to the smelter.

Swisshelm district (Webb).—The Colford Copper Co., operating the Jacob Scheerer claims, and the Swisshelm gold and silver property were the principal producers in 1919. Each of them produced lead ore, largely oxidized, containing some silver and gold. A small concentration mill was in course of completion on the property of the Colford Copper Co. The ores to be treated contain considerable wulfenite, the vanadate of lead.

Tombstone district.—Nine properties near Tombstone yielded 27,445 tons of ore and old tailings in 1919, the bulk of which was shipped directly to the smelter, and a small quantity was reported as yielding a little gold bullion. The total output of ore contained $40,220 in gold, 450,366 ounces of silver, 290,182 pounds of copper, and 289,424 pounds of lead, valued in all at $613,943, or an average of $22.37 a ton. Most of the ore carried silver, with lead and copper. The greater part of the production came from the Bunker Hill property; shipments were also made from the Hershell, Melgren, and Sunset groups. No manganese ore was shipped from the district in 1919.

Turquoise district (Courtland and Pearce).—The output of the district contained $60,480 in gold, 217,461 ounces of silver, 2,549,373 pounds of copper, and 18,009 pounds of lead, valued in all at $779,175. These metals were contained in 35,852 tons of crude ore and 36,813 tons of old tailings shipped to the smelters. There was also some silver bullion containing gold recovered from 3,308 tons of ore. The largest producer was the Commonwealth mine, yielding principally silver ore, followed by the Leadville, Great Western, and Copper Belle mines, yielding low-grade copper ores, both oxidized and sulphide. The Tejon property produced some siliceous ore containing lead, copper, silver, and some gold, which was mined in development work.

Warren district.—Eight properties produced 1,256,967 tons of ore, containing $823,594 in gold, 1,740,085 ounces of silver, 122,310,586 pounds of copper, and 4,525,105 pounds of lead, valued in all at $25,762,089, or an average of $20.50 a ton. Of this ore 1,199,406 tons

was of smelting grade and 55,651 tons was treated at milling plants, yielding 9,728 tons of concentrates, which contained 2,038.22 ounces of gold, 160,454 ounces of silver, 182,010 pounds of copper, and 4,432,655 pounds of lead. Some old slag containing copper and copper precipitates were also shipped to the smelter. The principal producers, the Copper Queen and Calumet & Arizona mines, shipped about equal quantities of copper ore to Douglas for treatment. Other properties producing ore in notable quantities were the Shattuck, Denn-Arizona, Higgins, and Wolverine mines.

The Copper Queen mines, according to the annual report of the Phelps Dodge Corporation for 1919, produced various kinds of ore as follows:

Ore and metals produced at Copper Queen mines, Arizona, 1919.

Kind of material and destination.	Quantity.	Gold.	Silver.	Copper.	Lead.
Shipped to Douglas:					
Copper ore—	*Shorttons.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Limestone, company	531,525	10,510	446,657	64,809,023	.....
Limestone, lease	55,366	230	42,804	2,944,517	.....
Sacramento Hill	7,220	43	1,267	218,683	.....
Virginia claim	17	1	15	2,286	.....
Shipped to El Paso:					
Silver ore	29	3	850	390	9,372
To experimental concentrator:					
Copper ore	8,027	.....	.....	.....	.....
	602,184	.....	.....	.....	.....
Shipped to Douglas:					
Precipitates	612	.....	73	415,767	.....
Slag and flue dust	1,910	1	284	48,458	.....
	604,706	.....	.....	.....	.....
Concentrates	1,680	25	376	174,878	.....
Total, 1919	.....	10,813	492,326	68,614,002	9,372
Total, 1918	.....	16,409	558,433	90,988,156	1,234,497
Total, 1917	.....	19,156	828,665	93,618,409	6,870,128
Total, 1916	.....	24,030	1,096,136	102,685,722	9,421,562

The production from leases amounted to 11,000 tons less than during the previous year, and almost 2,000,000 pounds of copper less. There was no lead ore production and only one carload of silver ore was shipped to El Paso. * * *

The total footage of exploration and development work, including winzes, shafts, and stations, was 48,907 feet, as compared with 58,396 feet in the previous year.

Due to the decrease in footage driven, the tons of ore developed per foot also resulted in a decrease as compared with the previous year's figures. This, again, was reflected in our ore reserve estimates at the end of the year, but it should be noted that, although the tonnage showed a small decrease, the copper contained in this tonnage was materially in excess of that in our reserves at the end of 1918. This was due to the development of the large body of oxidized ore in the Southwest division.

The two developments of especial interest were additions to the Southwest ore body referred to above and to the sulphide ore body in the Sacramento division on the ninth, tenth, eleventh, and twelfth levels, which is developed as a downward extension of the Sacramento Hill porphyry ore body.

The C. & C. shaft was sunk to 35 feet below the 1,800 level. A station was cut on that level and drifting started for water development before the end of the year.

There was no ore mined in the White Tail Deer.

Our direct mining costs per ton were slightly higher than for the preceding year. There were two principal causes for this, one being the larger footage of exploration and development work per ton of ore; the other being the

higher cost of power due to the increase in the price of fuel. The labor efficiency was better in all departments than for either of the preceding two years, while the average wage in the mine department was somewhat higher.

During the year we moved 2,056,700 cubic yards of waste in our stripping operations on Sacramento Hill. This makes a total yardage to date of 3,377,022 cubic yards, representing about 75 per cent of total waste to be moved before ore extraction is commenced. Efficiency showed a marked improvement and lower costs were obtained.

Construction on the new concentrator was actively resumed last August and orders placed for the necessary steel and equipment. From the result of test work on fine grinding carried on at one of our other branches, it was decided in July, 1919, to adopt the combined roughing table and flotation flow sheet for the Bisbee plant instead of the straight flotation plant as originally contemplated. It is anticipated that this will be completed during 1920.

From the Calumet & Arizona mines[4] 552,078 dry tons of ore was mined, of which 54,429 tons, high in sulphur content and low in copper, was sold to smelters for use in fluxing. At Douglas 511,987 dry tons of the company's ore was smelted, which yielded 28,530 ounces of gold, 995,366 ounces of silver, and 44,991,107 pounds of copper. Dividends paid in 1919 amounted to $1,927,563, which, added to the dividends paid since 1903, gives a total of $43,060,386.75. The company report contains the following paragraphs:

The year opened with a heavy balance of unsold copper in the hands of producers, as well as large unused quantities owned by the Governments of the United States, Great Britain and Ireland, France, and Italy, and with no demand from fabricators for civilian consumption.

Production and wages had been held at the maximum, but it was quite evident that such conditions could not be continued.

A policy of curtailment was necessarily adopted early in the year, but the quotation on copper sunk below 15 cents a pound with very limited sales during the first quarter of the year.

Demand for copper improved during the second quarter of the year, only to die during the third quarter. New life seemed to be wakened in November and record sales were made in December for delivery in 1920. As cash from these sales is not available, the inventory of bullion on hand at the close of the year shows a notable increase, which increase happily will be converted into cash in the treasury of the company at an early date.

The metal market for the year has depended mainly on domestic demand, although a very notable quantity has been sold for export to the Far East.

The Shattuck mine[5] produced both copper and lead ores valued at $1,017,358.69 in 1919. There was 22,256 tons of copper ore smelted at Douglas, yielding 300 ounces of gold, 89,724 ounces of silver, and 2,111,841 pounds of copper. At the concentration mill, to which the lead carbonate ore was shipped, the 49,059 tons of ore was first sulphidized and a flotation process used in the recovery of concentrate from it. This concentrate contained 4,432,655 pounds of lead, 160,078 ounces of silver, and 2,013 ounces of gold. In addition to the lead concentrate shipped to the El Paso smelter, a small quantity of crude carbonate ore was also shipped, containing an average of 0.076 ounce of gold and 33.09 ounces of silver per ton and 6.65 per cent of lead. The net operating cost per pound of copper was 22.4 cents and of lead 5.18 cents. The average price received for copper delivered was 24.376 cents a pound and that of milled lead was 6.27 cents a pound. Dividends paid since July, 1910, amount to $7,612,500, including $262,500 in 1919 from earnings and $87,500 from capital

[4] Calumet & Arizona Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

[5] Shattuck-Arizona Copper Co. Ann. Rept. for year ending Dec. 31, 1919. The Shattuck mill and process used are described in detail in the Eng. and Min. Jour., vol. 110, p. 759, Oct. 16, 1920.

distribution. From the company report reviewing the operations of the mill and the development of the mine the following was taken:

During the year mining operations for both copper and lead ores were curtailed on account of unsatisfactory conditions of the metal markets.

Lead operations were entirely suspended from January 15 to June 21. During the shutdown at the mill experimental work was carried on in the effort to make a greater recovery of the silver values. Following this experimental work alterations to the milling plant were made which resulted in a considerable saving in the operating labor and better metallurgical results when the milling plant resumed operations. The mill is now profitably treating 300 wet tons of lead ore daily. This tonnage will be increased to 450 tons daily early in the year (1920). * * *

Mining of copper ores was carried on at the rate of 200 tons per day from January 1 to February 22, 1919. A complete shutdown of operations was caused by an underground fire breaking out between the 700 and 800 foot levels of the mine in the abandoned and filled section of the low grade sulphide ore body. Gas and dense volumes of sulphur smoke penetrated the mine workings above the 800-foot level making operations unsafe for our employees. * * *

Mining of copper ore was resumed on a small scale in September. A gradual increase in ore output can be made as warranted by copper market conditions. The mine is now being operated one 8-hour shift daily with approximately 140 men employed underground, producing approximately 9,000 tons per month of combined lead and copper ores. * * *

The most important and promising development made during the past three years is now being opened up on the 100-foot level. The ore body is located south of our previously known ore zone, and although not large at present, the full limits of the body have not been reached and good developments can be expected during the coming year. The ore found in this new ore body is rich, assaying from 5 per cent to 28 per cent copper, 3 to 20 ounces of silver, and an average of $1.20 per ton in gold.

COCONINO COUNTY.

Francis district.—Small quantities of copper ore containing silver were shipped directly to the smelters from the Emerald and Grand Canyon properties.

Warm Springs district (*Fredonia*).—The Buckskin Mountain property was reported under development, the mill repaired, and improvements made tending toward bringing the property into shape to produce in 1920.

GILA COUNTY.

Mine production in Gila County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	45	7,807,714	$137,641	477,041	207,643,252	51,805	$51,906,243
1919	46	6,374,240	163,311	439,647	176,527,981	94,526	33,494,930
Increase or decrease, 1919.	+1	−1,433,474	+25,670	−37,394	−31,115,271	+42,721	−18,411,313

The total average value per ton of the ore sold or treated in Gila County decreased from $6.65 in 1918 to $5.25 in 1919, but the gold and silver value increased from 8 to 10 cents a ton. The output of gold, valued at $137,641 in 1918, increased to $163,311 in 1919; silver increased in value from $477,041 to $492,405; and lead from $3,678

to $5,910; but copper decreased from $51,287,883 to $32,834,204. No zinc was produced in 1919. Of the ores produced, 6,132,833 tons was of concentrating grade and produced 299,635 tons of concentrate, containing 4,760.79 ounces of gold, 260,509 ounces of silver, and 154,491,616 pounds of copper. The crude ores, mostly copper ore, shipped directly to the smelters amounted to 241,404 tons, against 337,309 tons in 1918. The crude ores in 1919 contained 3,082.04 ounces of gold, 179,127 ounces of silver, 22,036,365 pounds of copper, and 94,526 pounds of lead. All the ore produced was treated in the district, except lead ores and some copper ores, which were shipped to plants outside of the county. Of the copper ores smelted, 47,308 tons was oxidized and 193,322 tons sulphides. The smelting ores shipped were valued at $4,368,108, or an average value per ton of $18.09, and the concentrates, chiefly copper, were valued at $29,125,625, or an average value per ton of $47.49.

Banner district.—Seven properties in 1919 produced 93,665 tons of ore, containing $15,463 in gold, 31,157 ounces of silver, 5,419,897 pounds of copper, and 25,564 pounds of lead, valued in all at $1,059,815, or an average of $11.32 a ton. The greater part of the ore, containing copper and a little silver, came from the Christmas and Snyder Gulch properties. The Apex mine, better known as the Lavell property, produced lead ore containing much gold. Small shipments of copper ore were made from a number of other properties. The Lavell mine is equipped with a 50-ton mill containing crusher, Quinner pulverizer, amalgamating plates, and concentrators. A 4-mile road between the mine and the mill was recently completed.

Dripping Springs district (Winkelman).—A few tons of gold ore was milled from the Cow Boy property, yielding gold bullion recovered by amalgamation. Active operations were carried on at the Columbia & Gladys group, where some ore containing copper, lead, molybdenum, and manganese was developed.

Globe (Miami) district.—A recent paper[6] describes the geology and the enriched disseminated ore deposits of the Globe district. The 36 mines in the district produced 6,280,470 tons of ore in 1919, the largest part of which came from the Inspiration, Miami, and Old Dominion properties. The ore, largely of milling grade, contained $146,663 in gold, 402,530 ounces of silver, 171,106,182 pounds of copper, and 67,078 pounds of lead, valued in all at $32,426,802, or an average of $5.16 a ton. The output includes the ore directly smelted—147,637 tons—and 6,132,833 tons of milling ore reduced to 299,635 tons of concentrate. Included in the ore shipped to smelters was a small quantity of lead ore shipped to El Paso, Tex. Lessees shipped ore from the Black Warrior property. The Summit mine (Gibson property) produced milling ore which was treated in its new mill. A small quantity of lead ore produced from the Irene claim was mined by lessees.

The Old Dominion mine[7] produced 253,686 dry tons of ore, averaging 4.28 per cent of copper. This output consisted of 50,188 tons of smelting ore averaging 6.61 per cent of copper; 200,304 tons of concentrating ore averaging 3.69 per cent; and 3,194 tons of siliceous

[6] Ransome, F. L., The copper deposits of Ray and Miami, Ariz.: U. S. Geol. Survey Prof. Paper 115, 192 pp. 1919.
[7] Old Dominion Co. Ann. Rept. for year ending Dec. 31, 1919.

ore, used for converter lining, averaging 4.76 per cent. The total metal output in 1919, including that from custom ores treated at the Old Dominion smelter and copper concentrates treated at the International smelter at Miami, was 28,166,396 pounds of refined copper, 137,071 ounces of silver, and 5,755.79 ounces of gold. Of the copper produced, 17,124,913 pounds was sold and delivered at an average price of 17.28 cents a pound. Dividends paid since 1905 amount to $14,405,260, but none were distributed in 1919. Interesting disclosures in the mine are related in the company's report, part of which follows:

The 1½ level on the west side became an important producer of smelting ore during the year, about 7,000 tons being obtained from this source; this level will also continue to be an important producer in the coming year. A small tonnage was mined on the fifth, sixth, ninth, tenth, eleventh, twelfth, thirteenth, and fourteenth levels; a greater part of the tonnage being mined from the fifteenth, sixteenth, seventeenth and eighteenth levels. No stoping was done on the nineteenth or twentieth levels during the year, but a small tonnage was extracted from development on these levels.

The east side ore body has supplied the greater part of the production of concentrating ore during the year and an appreciable part of the smelting ore. A small tonnage of good concentrating ore was obtained on the twelfth level and 20,000 tons were produced on the fourteenth level and about 15,000 tons of ore on the fifteenth level. The sixteenth level yielded 44,000 tons of ore which was rather low grade, but there is still considerable tonnage available. The seventeenth level produced 48,000 tons of ore in blocks 27 to 31, with a slight production from blocks 33 and 36. The ore on this level is of good grade and a considerable amount is sorted out for smelting ore—it will be a very important producer in the coming year. The eighteenth level yielded 12,000 tons of ore, largely concentrating. A little stoping was done in blocks 27 and 30, but a large tonnage came from development work.

The Grey No. 3 vein yielded 6,000 tons, largely good concentrating ore, during the year. All of this came from above the tenth level and a good tonnage is still available above this level and probably considerable between the tenth and eleventh levels.

There were 3,372 tons of ore produced from various small leases close to the surface; and 8,442 tons of Hoosier Flux ore were mined and treated during the year. * * *

Neither the ore developed, the total amount of development work done, nor the tons of ore mined per foot of development gives a true measure of the development performance for the year. In the face of a large flow of water the "A" shaft was sunk 102 feet and work started on the cutting of the twentieth level station. The West winze was sunk from the twentieth to the twenty-second level, the Grey shaft from the twelfth to the fourteenth level, and the "K" shaft from the nineteenth to the twenty-first level. All of this work was necessarily slow and expensive but it has put the mine in excellent position to open up new levels and rapidly develop a large tonnage of ore.

Developed and prospective concentrating ore, over 2.5 per cent in grade, increased from 731,882 tons at the beginning of the year to 1,172,053 tons at the close of the year, an increase of 440,171 tons, or 60 per cent. * * * Smelting reserves of developed and prospective ore decreased from 82,976 tons at the beginning of the year to 42,701 tons at the end of the year, a decrease of 40,275 tons. As approximately 24,000 tons of this reserve is not available, our smelting ore reserves are down to 18,000 tons. In addition to this, there is considerable smelting ore mixed with the concentrating ores between the sixteenth and eighteenth levels from block 27 eastward which it is impossible to estimate, but which will probably produce 80,000 to 90,000 tons. This ore, however, can only be mined with its associated concentrating ore, and consequently can not be depended upon as a steady source of smelting ore.

Just below the nineteenth level the "A" shaft began to show mineralization, which has continued to the present bottom, 6 feet below the twentieth level. The average of all material taken out of shaft was 1.2 per cent in copper. This copper occurs in the form of chalcopyrite and bornite as specks and veinlets in Cambrian lower quartzite, and will give a high ratio of concentra-

tion. This interesting occurrence led to the driving of a crosscut north from the "A" shaft on the eighteenth level and the subsequent discovery and partial development of what has been assumed to be a continuation of the Maggie vein. * * *

Development on the nineteenth and twentieth levels west was decidedly discouraging, although several small occurrences of concentrating ore were encountered. The high-grade secondary ores which were expected under the oxidized showing on the eighteenth level were conspicuously absent until near the end of the year when in block 13 west on the nineteenth level the crosscut toward the hanging wall encountered oxidized material, with some very nice irony oxidized smelting ore irregularly scattered through it. On December 31 the last 30 feet of this drift averaged 4.5 per cent copper, about half of this being material running 7 to 9 per cent, and the other half 1 to 2 per cent. * * *

The results of the development indicate, perhaps more strongly than has been indicated previously, that for the present at least the company's principal source of income will be from concentrating ores rather than, as in the past, from smelting ore, and because of this fact the construction of a new 1,000-ton mill unit is contemplated. * * *

The great handicap which the company now has is the fact that there was not sufficient development work done in the years 1916, 1917, and 1918 to insure a normal supply of ores in succeeding years. * * *

It has been demonstrated beyond doubt that the Old Dominion should sink deeper and have the ground drained well in advance of level development; this is necessary in order that the ground may be thoroughly drained and dried before mining is attempted. This work is very expensive and necessarily slow, especially in the "A" shaft, where there is always a large flow of water. There has been a constant flow of water coming from the dacite in the west end of the mine on the twelfth level; below this level the western part of the mine is comparatively dry. However, the whole territory to the east of this shaft has had to be drained, and when once drained remains practically dry. In other words, there is no perennial flow of water as on the twelfth level west. Undoubtedly the pumping which the Arizona Commercial Mining Co. is doing relieves the Old Dominion from a considerable burden, as it is probable that pumping by the Arizona Commercial drains a large part of the country east of the Budget fault, together with a certain amount of the country west of the Budget fault.

The Inspiration mine[8] produced 4,175,631 dry tons of ore, of which 4,151,806 tons was concentrated and the remainder was of smelting grade from the main shafts and the Live Oak and Keystone sections of the property. At the concentrator 11,501 tons of ore a day were treated. Altogether 78,038,306 pounds of copper was obtained at a cost of 13.412 cents a pound of fine copper. This average cost does not include depletion and Federal taxes. The yield in fine copper from concentrating ores mined during 1919 was 18.61 pounds per ton. Dividends declared in 1919 aggregated $7,091,802, or $6 a share. The company's annual report contains the following paragraphs:

The sulphide concentrating ore extracted during the year was obtained from the Inspiration division. A small tonnage of siliceous oxidized ore was extracted from the Live Oak division, and also from the old workings of the Keystone property. * * * The ore was mined at the rate of 17.94 tons per man shift for all labor chargeable to the mining division as compared with 21.5 tons for the preceding year. The difference is accounted for by the large amount of development work performed, and does not indicate any decrease in efficiency; on the contrary, operations were conducted upon a more efficient basis than during the preceding year. * * *

A total of 21.33 miles of underground openings were driven, making a total of 149.18 miles driven in the property to the end of the year, and 6.13 miles of underground workings were destroyed in the process of mining. * * *

Work on the drift on the 600 level through the Live Oak property, which had been discontinued in 1913, was resumed, and in the latter part of the year

[8] Inspiration Consolidated Copper Co. Ann. Rept. for year ending Dec. 31, 1919.

the May drift was completed. The total length of the drift from Live Oak to the main shaft is 7,888 feet. * * * The development work was confined within the area previously prospected by churn drilling, so that no new discoveries were made nor was any additional ore developed. * * *

The concentrator operated with an average of 11 of the 20 sections in operation on Inspiration ore averaging 1.304 per cent of copper, carrying 0.263 per cent copper in oxides. * * *

An improvement in recovery was effected; 90.63 per cent of copper in the sulphides and 74.56 per cent total copper was obtained, as compared with 88.51 per cent and 72.99 per cent, respectively, for the preceding year. The excess insolubles in general concentrates was reduced to 13.3 per cent, as compared with 21.6 per cent for the previous year. * * *

The erection of the 35-ton experimental leaching plant started in 1918 and was completed and operations were begun on June 24, 1919. The results of the tests upon about 5,000 tons of oxidized and mixed ores have been satisfactory and indicate that the oxidized ores of the company can be readily and economically treated by sulphuric-acid leaching. The experiments have likewise indicated that the copper can be economically recovered by electrolytic deposition. Experiments were being continued at the end of the year. It is expected that it will soon be possible to make final decision as to the treatment of these ores.

The refined copper from the ore of the Miami property[9] amounted to 54,221,638 pounds in 1919, produced by the concentration of 1,698,446 tons of ore averaging 2.04 per cent of copper. The concentrate recovered contained an average of 43.54 per cent of copper in the 65,544 tons smelted. The cost of milling the ore to the point of concentrate f. o. b. cars was 92 cents a ton. This was 20 cents higher than in 1918, principally owing to a 50 per cent increase in the price of copper accounted for by the advance in the price of fuel oil, and also to an increase in the experimental work. The mining cost was $1.54 a ton of ore, and the general expenses 45 cents, or a total of $2.91 a ton, equal to 9.1 cents a pound of refined copper. The cost with Federal taxes added, including the cost of renewals and repairs, was 15.81 cents a pound, as given in the company's annual report, from which the following data are taken:

Underground development work to the amount of 14,552 feet was done during the year, made up of 12,937 feet of drifts, 1,587 feet of raises, and 28 feet of shaft sinking. * * *

Of this development work 75 per cent was for the purpose of preparing for and maintaining ore production from the Main ore body by the undercut caving system of mining, which was introduced in this ore body during the year. Of the remainder of the development work, the greater part was done on the 720-foot level from No. 4 shaft to prepare for mining the Main ore body below the 570-foot haulage level, which will be started immediately upon the completion of the No. 5 shaft and equipment during the latter part of the year 1920.

The underground work in connection with sinking No. 5 shaft was completed, and this amounted to 936 feet of shaft and 363 feet of station drifts. At present we are engaged in driving drifts on all levels from this shaft to connect with the operating mine workings. * * *

On December 22 mining by top slicing, which had been in operation since the opening of the mine, was discontinued in favor of the undercut caving method developed in the Captain ore body during the past five years. At the end of the year the full tonnage is being produced by the undercut caving method of mining from the Main ore body and to a lesser extent from the Captain ore body. The ore at present available from this latter ore body will be exhausted next May, and after that date the full mill tonnage will be produced from the Main ore body. * * *

During the year considerable experimental work was carried on in an effort to find a suitable process for the treatment of the mixed sulphide and oxide ore body, but with no definite results. * * *

[9] Miami Copper Co. Ann. Rept. for year ending Dec. 31, 1919.

New development during the year resulted in very slight changes in the boundary of the high-grade ore body, and careful estimates place the tonnage of this class of ore at 11,054,349 tons of an average grade of 2.38 per cent copper.

There was very little churn drilling done and this was confined to the low-grade area, consisting of completing hole No. 117 for a depth of 469 feet, which terminated the drilling program for the present. As no new information was gained regarding this ore body, it is reported at the same tonnage and grade as last year, namely, 36,000,000 tons of an average grade by drill sampling of 1.06 per cent copper.

The same conditions apply to the mixed sulphide and oxide ore body, and this also is reported at the same figure as last year, namely, 6,000,000 tons, averaging approximately 2 per cent copper.

The Arizona Commercial mine[10] produced 76,572 dry tons of ore, which included 11,393 tons of smelting ore, averaging 9.11 per cent of copper; 65,169 tons of concentrating ore, averaging 4.94 per cent of copper; and 10 tons of ore mined by lessees, averaging 11.90 per cent of copper. From the ore concentrated and smelted, 7,280,861 pounds of copper, 16,917.65 ounces of silver, and 1,310 ounces of gold were recovered at the Old Dominion smelter. No dividends were paid in 1919. The company's annual report says:

The company has been operated during the year with the idea of developing additional reserves of ore more than with the idea of producing a maximum amount of copper. In fact, the copper can not be produced at the present time as economically as it can be produced after the new shaft is finished and equipped, and a large production can not be made until the company has additional facilities for treatment of ores. * * *

At the time of making the last report the lowest level in the mine was the fifteenth, and though this level had been but superficially developed it had shown a continuation of the good ore bodies found in the levels both west of the fault up to the thirteenth level and east of the fault up to the eighth level. During the year development has proceeded on the sixteenth level and two crosscuts through the vein have been made, showing a continuation of a strong vein with mineralization as good or better than in the levels above. Also east of the fault in the vicinity of the No. 2 shaft upraises have been made from the eighth level to the sixth level, showing a continuation of a strong vein with normal mineralization on both the sixth and seventh levels. Recent development on the sixth level is particularly good, although to date the vein has not been explored laterally for any great distance. This development on the sixth level is especially pleasing, because it would not have been surprising if the vein had been very low grade in this section. It is very interesting that all of the development carried on during the year has been productive of excellent results in developing additional good ore. It is also interesting that the average cost of producing copper, even under conditions as they have obtained with high wages and the maximum cost for all supplies, has been low.

During its fiscal year the Superior & Boston mine[11] yielded 773 dry tons of ore, averaging 3.86 per cent of copper and 0.17 ounce of silver, for which $6,174 was paid. Lessees working on the property shipped 412 tons of ore, valued at $12,750. Concerning developments the company report says:

The Old Dominion vein has been an exceedingly profitable one in neighboring mines. The ore bodies have been found in nearly all of the different sedimentary wall rocks which occur in this district, but to date none of the mines have opened the vein entirely within the Pinal schist, which underlies our sedimentaries. There is no geological reason why the vein should not carry good primary ore in schist walls, and there is good reason to hope and believe that it will do so.

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[10] Arizona Commercial Mining Co. Ann. Rept. for year ending Dec. 31, 1919.
[11] Superior & Boston Copper Co. Ann. Rept. for year ending Sept. 30, 1919.

Inasmuch as mining exploration in these schists would be below our present pumping station on the 1,200-foot level and would, of necessity, be exceedingly costly, it was decided to do this prospecting work by diamond drills. Six holes have been planned, and this work is now in progress. The first hole is expected to find the Old Dominion vein at about 800-foot depth. It is now down 245 feet. Exceedingly interesting developments may be expected from this hole in the near future.

From 64,540 dry tons of ore produced from the Iron Cap mine[12] at Copper Hill, 7,156,270 pounds of copper and 104,458 ounces of silver were recovered. Only 5,823,008 pounds of the total copper was sold, for which an average of 18.9 cents a pound was realized. In September temporary arrangements were made to use one section of the Inspiration concentrator until the completion of the Iron Cap mill in May, 1920. Altogether 13,559.7 tons of ore was milled, producing concentrate which, with the ore shipped directly to the smelter, was valued at $1,101,612 for the copper and $121,236 for the gold and silver. Development work was continued, and the shaft reached a depth of 1,316 feet early in 1919. Dividends have been paid since July, 1917, including $72,948 paid in 1919.

In December the Gibson Co. was producing about 11 tons of concentrate a day in its new mill. A copper vein 4 feet wide is said to have been opened on the 400-foot level. The company is drilling below the 1,200-foot level to pick up extensions of known ore bodies.

Green Valley district (*Payson*).—No production was reported from this district, but a little development work was done on the Silver Butte property.

Richmond Basin district.—Siliceous silver ore, containing some copper and lead, was shipped from the Jumbo property, operated by the Gila Monster Mining Co. The property is equipped with a 50-ton cyanide plant, which was not in operation in 1919.

GRAHAM COUNTY.

Four producers in Graham County in 1919 reported 2,456 tons of ore, containing gold, silver, copper, and lead, valued at $62,517. Most of this ore was concentrated and was produced principally in the Aravaipa district.

Aravaipa district.—Lessees operating the Grand Reef property shipped considerable lead concentrate containing silver and copper. Some lead ore was also shipped from two other properties.

Black Rock district (*Geronimo*).—Shipments of copper ore were made from the Ruby group, which is opened by a tunnel and shaft.

GREENLEE COUNTY.

Mine production in Greenlee County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces*	*Pounds.*	*Pounds.*	
1918	23	2,102,725	$79,438	142,399	71,868,688	10,026	$17,974,115
1919	14	1,301,199	70,002	106,241	44,867,643	1,294	8,534,443
Decrease, 1919	9	801,526	9,436	36,158	27,001,045	8,732	9,439,672

[12] Iron Cap Copper Co. Second Ann. Rept., for year ending Dec. 31, 1919.

The ore sold or treated in Greenlee County in 1919 averaged $6.56 a ton, against $8.55 in 1918. The gold and silver reported from the refining of copper bullion amounted to only 14 cents a ton. The concentrating ores aggregated 1,232,971 tons and produced 134,993 tons of concentrates, which contained $50,112 in gold, 67,759 ounces of silver, and 36,784,452 pounds of copper, valued in all at $6,967,910, or an average of $51.62 a ton. The ore smelted (56,266 tons) was mostly copper ore, of which 11,338 tons was classed as oxidized ore and 44,002 tons as sulphide. No placer production was reported in 1919.

Ashpeak district (*Duncan*).—Silver ore containing considerable gold and a little lead was shipped from one property in the district to El Paso, Tex. Some silver ore was produced from the Commerce claim.

Copper Mountain and Greenlee districts (*Morenci, Metcalf, and Clifton*).—The largest part of the county production given in the table above represents the combined total of these two districts, of which Greenlee is credited with 1,009,836 tons of milling ore and 30,723 tons of ore directly smelted and Copper Mountain with 233,135 tons of milling ore and 25,481 tons of ore directly smelted. Lessees shipped some copper ore containing silver from the Keyting and Stevens groups and the Pitt mine. Shipments of silver ore were also made from the Stargo property. The Shannon Copper Co. completed the sale of its mining property on October 7 to the Arizona Copper Co.

At Morenci the Detroit mine [13] produced 228,488 tons of concentrating ore assaying 2.365 per cent of copper, which yielded 1.776 per cent of fine copper. The company also treated 21,026 tons of smelting ore assaying 7.28 per cent of copper, from which 6.84 per cent of fine copper was recovered. This ore, with 817 tons of old tailing, 2,876 tons of siliceous ore, and 32,996 tons of concentrate, produced 11,414,031 pounds of fine copper. At the concentrator the savings averaged 80.22 per cent, and the ratio of concentration was 6.76 tons of ore to 1 of concentrate. The company's report gives a distribution of the ore from the mines by classes as follows:

Ores produced at the Detroit mine, Morenci, Ariz., in 1919, in short tons.

Mine.	Total.	Second class.	Belt sulphide.	Copper Mountain sulphide.	First class.	Cleanings.	Precipitates.
Ryerson	42,181	39,816	2,225	.....	140	.....	.....
Colorado	939	939	.....	.....	.....	.....	.....
Yankie	67,835	67,759	.....	.....	24	.....	52
Copper Mountain	50,587	40,776	.....	9,811	.....	.....	.....
Arizona Central	92,130	91,499	580	.....	.....	12	39
Santa Rosa	20	.....	.....	.....	20	.....	.....
	253,692	240,789	2,805	9,811	184	12	91

Extracts from the fiscal report [14] of the Arizona Copper Co. follow:

During the year our production of copper was 36,474,000 pounds, which compares with 40,442,000 pounds for the previous year.

[13] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31, 1919.
[14] Arizona Copper Co. Ann. Rept. for year ending Sept. 30, 1919.

The total ore mined from the company's properties amounted to 1,147,659 tons, as compared with 1,095,568 tons in the previous year, and the yield, as indicated by the smelter returns from ores treated, was 32.21 pounds of copper per ton of ore, which compares with the yield of 35.08 pounds per ton treated during the previous year. * * *

Small benefit has been derived from the result of operations, except that of maintaining our organization, which, if disbanded, would involve a protracted delay when the time came for a resumption of operations; for, notwithstanding the cutting down of expense wherever possible, costs, which would inevitably have been high, whether running on full scale or not, were naturally still more adversely affected by the reduction in our output; for the cost of all supplies entering into the production of copper has gone on advancing since the end of the war, while, to meet the constantly increasing cost of living, wages throughout the industry, in this and other States, were still further increased, as lately as July of this year. * * *

The daily output of ores was 3,750 tons, as compared with 3,320 tons for the previous year.

The grade of smelting ore produced was 6.45 per cent of copper, and the grade of concentrating ore treated was 2.123 per cent.

In order to meet the situation referred to above, the Coronado mine was shut down in March and the King and Longfellow in April.

Development on the lower levels of the Humboldt mine carried on during the year has been satisfactory and has resulted in exposing, approximately, as much new ore as, and of a similar grade to, that shipped to the concentrator during the same period.

In the Clay mine the development of our low-grade ore body has proceeded steadily and satisfactorily as far as tonnage is concerned, but the grade of this ore is not at present commercial.

The ore body in the Pyramid mine has been extended somewhat since the last report, but the grade of ore developed during the year has been low, averaging somewhat less than 2 per cent.

Development in the King mine was, at the time of closing down of operations, proceeding satisfactorily and had exposed a new ore body of good grade of concentrating ore further to the north than any previously found, and it is much to be regretted that conditions have rendered the stoppage of this work necessary.

Some interesting discoveries of ore have been made in underground development in the Princess Alice and Spartan claims, which, although on a very small scale, entered the shipping list during the year with promising prospects when work is resumed.

There is nothing of interest to report concerning developments in the Coronado and Horse Shoe mines: the 1,100-foot adit was driven 1,412 feet during the year, and at September 30 was in 12,253 feet from the portal and approaching the Bluebell ore shoot, which it has since reached and development of it begun.

Prospecting with churn drills on the Badger group of claims, lying between the Coronado incline and the Metcalf, yielded negative results, and was shut down in July after six holes of 700 feet in depth had been put down. * * *

Since the last report the property of the Shannon Copper Co. in this district was acquired by us; this consists of 73 mining claims, comprising 1,078 acres, most of which is contiguous to our own mines, and capable of being easily reached and developed from our own workings and connected up with our own transportation systems. * * *

Other Shannon property taken over consists of 550 acres of land in the vicinity of Clifton, a narrow-gage railroad 10 miles in length, and an old concentrating and smelting plant which is now being dismantled, house property, etc. * * *

The total ore treated by concentrators during the year was 1,111,522 dry tons.

No. 6 concentrator, at Morenci, treated 1,019,203 dry tons, of an average grade of 2.14 per cent copper, of which 0.32 per cent was in oxidized form, and a total extraction of 74.25 per cent was obtained. Since April the concentrator has been operated but sixteen hours per day.

No. 4 concentrator, at Clifton, treated 92,319 dry tons during the period, the average grade of which was 1.99 per cent copper, of which 0.38 per cent was oxide, the extraction from which was 69.37 per cent. This concentrator was closed down in April. * * *

The total amount of new material smelted during the year was 174,155 dry tons, and the average per working day was 491 tons.

Two furnaces were in operation 118 days, and one furnace 241 days. During the year there was recovered from the old Clifton smelter site 15,708 tons of slag and refuse, averaging 3.32 per cent copper, and up to that date there has been recovered from this source 81,655 tons, averaging 3.99 per cent copper.

MARICOPA COUNTY.

The output of 157 tons of ore in Maricopa County in 1919, reported by five producers, was 160 tons less than was reported by seven producers in 1918. The total average value per ton decreased from $51.28 in 1918 to $50.55 in 1919, and the gold and silver value of this ore from $9.62 to $4.98. All the ore was of shipping grade. The total value of all the ore amounted to $7,936, a decrease from $16,256 in 1918. A small quantity of placer bullion was reported in 1919.

Big Horn district (*Aguila*).—Copper ore containing principally gold and a little silver was shipped from the Hauxhurst group in 1919.

Fourmile district (*Phoenix*).—A small shipment of copper ore was made from the Arizona & Copper Hill claims in 1919.

Gila Bend section.—The Rowley mine was equipped with a power plant in 1919, and a small lot of ore containing the mineral wulfenite was shipped to Los Angeles, probably for testing purposes. In December sinking was started on a 7 by 9 foot shaft, now 250 feet deep, to a depth of 500 feet. The company has a small concentration mill.

San Domingo district.—Some development work and the experimental operation of the amalgamation and concentration mill on the Dragon property was reported in 1919. It is estimated that the placers produced about $350 in gold dust in 1919, as reported by the purchasers of the product.

White Picacho district (*Morristown*).—Lead ore containing silver was shipped to El Paso, Tex., from the Montezuma property in 1919. There were also test shipments of copper ore containing gold and a little silver from the Big Four group, 8 miles northeast of Morristown.

MOHAVE COUNTY.

Mine production in Mohave County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	60	192,585	$2,798,903	114,707	528,346	587,814	82,853	$3,093,386
1919	40	201,040	2,582,331	164,517	302,667	916,818	.....	2,871,477
Increase or decrease, 1919...	−20	+8,455	−216,572	+49,810	−225,679	+329,004	−82,853	−221,909

The total average value per ton of the ore produced by 40 operators in Mohave County decreased from $16.07 to $14.28 and the gold and silver value from $15.13 to $13.76 per ton. The total gold decreased in value from $2,798,903 in 1918 to $2,582,331 in 1919, and the copper

from $130,501 to $56,296; but the value of silver increased from $114,707 to $184,259, and the lead from $41,735 to $48,591. No zinc was reported in 1919. Most of the ore produced in the county is of milling grade and yields bullion or concentrates. There were 187,603 tons of ore treated by amalgamation or cyanidation, which produced $2,561,961 in gold and 73,449 ounces of silver, having a total value of $2,644,224, or an average of $14.09 a ton. The concentrating ores aggregated 10,145 tons and produced 596 tons of concentrates, against 4,670 tons of ore and 272 tons of concentrates in 1918. The concentrates in 1919 contained $1,821 in gold, 37,733 ounces of silver, 34,357 pounds of copper, and 399,507 pounds of lead, having a total value of $71,647, or an average of $120.21 a ton. Crude ore shipped to smelters amounted to 2,371 tons, against 3,455 tons in 1918. In 1919 shipping ore contained $18,515 in gold, 51,648 ounces of silver, 187,874 pounds of copper, and 517,311 pounds of lead, and had a total value of $138,721, or an average of $58.51 a ton.

Bentley district.—Copper ore containing silver continued to be shipped from the Adams or Grand Gulch property to a smelter near Salt Lake. There were also shipments from the Savanic or Bronzell mine, but on account of the high cost of materials and labor the Copper Mountain Co. is said to have held up shipments of ore taken out by lessees during the first part of 1919, and the mine was closed in October.

Cedar Valley district.—Copper ore containing a little silver and some lead was produced from the Yucca Tungsten, Copper World, and Antler properties, and some lead ore containing silver was shipped from the Diamond Joe claim. Tungsten was also recovered from a copper concentrate from the Yucca Tungsten property.

Gold Basin district.—The Cyclopic mine and 50-ton cyanide plant were operated during 1919 and some gold precipitates were shipped to California, and from the Lynx claim siliceous ore containing lead and gold was shipped to El Paso, Tex. With smelting charges of $12 a ton and equal costs for hauling, it is reported that ore shipped did not pay expenses.

Greenwood district.—In 1919 the McCracken property, consisting of the Atlanta Extension and Otsego claims, produced considerable shipping and milling ore. The latter was treated in its dry concentration mill, which was completed during the year. The mine is opened by a 300-foot shaft and 2,500 feet of drifting.

Hackberry district.—From the Sunshine and Hackberry claims a large output of milling ore was treated in the new plant of the Hackberry Consolidated Mining Co., which is equipped for flotation and table concentration. The product shipped from this property contains principally silver with some gold and a little copper. Lack of development work in the mine is said to have caused the cessation of operations near the close of 1919. Considerable development work was performed on the Senate silver property, where operations were commenced in June and consisted of sinking and drifting.

Maynard district.—The Silver King claim was operated and produced some silver ore of shipping grade taken out in the course of development. The product sold was sulphide ore in a siliceous gangue.

San Francisco district (Oatman and Goldroad).—Six properties produced 184,490 tons of ore, containing $2,556,197 in gold and

71,83- ounces of silver, valued in all at $2,636,650, or an average of $14.29 a ton. The larger part of the output came from two properties equipped with cyanidation plants. In 1918 the total output of 11 properties was valued at $2,843,423, or an average of $15.55 a ton. The largest producers in 1919 were the United Eastern and Tom Reed mines, and smaller outputs came from the Arabian, Gold Trails, and Pioneer properties. Active operations were carried on by 16 companies, but no reports were received as to the probable ores that these properties will produce in the future.

The United Eastern mine[15] in 1919 produced 97,325 tons of ore, against 90,949 tons in 1918. A labor strike in August and September interfered with the development of the mine and a greater output of ore. The shortage of labor for the remainder of the year made it difficult to keep the mill supplied with its normal quantity of ore. In 1919 the gold recovered was 91,263.80 ounces, valued at $1,907,258.42, and 55,973.68 ounces of silver, valued at $63,250.74, or a total value of $1,970,509.16. The tailing from the ore treated contained 2,863.10 ounces of gold, valued at $59,185.43, and 1,711.08 ounces of silver, valued at $1,899.61, making a total loss of $61,085.04, or 62.7 cents a ton. The total value of the gold and silver contained in the ore was $2,031,594.20, or $20.87 a ton. Mining costs averaged $5.08 a ton and direct milling costs $2.01 a ton, which, with shaft sinking 14 cents a ton, marketing 11 cents a ton, and indirect costs $1.72, gave a total of $9.22 for all operations and expenses. Adding the tailing loss of 62.7 cents a ton brings the total to $9.85, or a net income from operations in 1919 of $11.03 a ton, or $1,073,935.04. Dividends paid since 1917 amounted to $2,153,540, of which $899,580 was paid in 1919. The company's report says:

All of the ore milled was produced from the Tom Reed Extension claim. The main ore body has been mined out above the fifth (565-foot) level, and the bulk of the ore is now being taken from the sixth (665-foot), seventh (815-foot), and eighth (965-foot) levels. * * *

The main shaft was sunk to the tenth (1165-foot) level, where a crosscut was driven to the vein and 151 feet of drifting was done. Up to this point no commercial ore was found. The level and shaft filled with water almost to the eighth level during the strike, but it has now been unwatered and preparations are being made to resume drifting on the tenth level. * * *

The capacity of the mill has been still further increased to a daily average of 325 tons of ore. * * *

The rate of extraction continues to be satisfactory, and was 96.99 per cent for 1919, as compared with 96.95 per cent for 1918. * * *

Operating costs were again forced upward by increases in wages, by labor troubles, and by increased taxes. There were changes in the prices of supplies, some of which increased and others decreased. The notable increases were in the prices of timber, lime, and repair parts for machinery. There was a slight decrease in the average price of powder, cyanide, grinding balls, and some general supplies. Some important economies were effected, but the savings made by them were not sufficient to offset the heavy increase in the cost of labor, strike, and taxes, and the net result was an increase in the cost of production over that of 1918.

Direct mining costs were 35.8 cents higher in 1919 than in 1918. Most of the increase was in wages, which accounts for 34 cents, and in the cost of timber, which accounts for 6.4 cents of the increase. The cost of other commodities used per ton decreased 4.6 cents. * * *

The principal saving of material was in repair parts, and in cyanide, which was reduced from the 1918 consumption of 0.747 pound per ton of ore to 0.639 pound per ton. * * *

[15] United Eastern Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

The foregoing remarks relate to 1919 expenses as compared with those of 1918, but it is desirable at this time to compare current costs with those of 1915. Since that time wages have increased four times, the combined increases amounting to $2 per day. The cost of timber has risen from $42 per thousand to $75 per thousand. Powder, steel, and all machinery supplies have advanced proportionately. Powder has advanced 10 per cent. Taxes have been greatly increased. The turnover of labor is greater and its general efficiency less. These increases explain the high working cost of the present day and show that it is no longer possible to work at costs comparable with those of five years ago.

The mill at the United Eastern mine is a modern plant for treating gold ores by the cyanide process. It is equipped to use single-stage crushing, followed by two-stage grinding with short ball mills in cyanide solution and straight countercurrent decantation. The mill is described in recent publications.[16]

The Tom Reed mine[17] produced 89,557 tons of ore in 1919, from which gold and silver valued at $679,986.41 were recovered by cyanidation, or an average of $7.94 a ton, compared with $9.05 in 1918. The reported loss in the tailing was 34 cents a ton, against 37 cents in 1918. Parts of the company's annual report follow:

Between the 400 and 500 foot levels of the Aztec, stoping has been carried on by the "shrinkage" method. In this particular block of ore the walls of the vein have been good, which has allowed us to take advantage of this cheaper method of mining.

Stoping operations were continued on the Bald Eagle ore body, both from the 400 and 500 foot levels. The walls of the vein here are soft, and the stopes required immediate filling, necessitating the employment of the more expensive system of mining, viz, the "cut and fill" method. * * *

The ore body on the 600-foot level of the Bald Eagle has been developed by sinking a winze in the foot wall from the 500-foot level. * * *

During the fiscal year ending March 31, 1920, the mill and cyanide plant reduced and treated 89,557 tons of ore from the mines and 103 tons of scrapings from the tailings pond. * * *

The company encountered an interruption in production during the year, otherwise a greater tonnage of ore could have been handled. Notwithstanding the interruption 89,557 tons, of an average value of $7.94 a ton, were milled at an operating profit of $176,348.17, thereby indicating that the production cost per unit was nearly as low during the current year as during the previous year, in the face of increased wages and increased material costs. * * *

Direct mining costs, including cost of ore broken in development, but not total development costs, increased from $2.60 per ton in 1919 to $2.87 in 1920, an increase of 27 cents per ton. * * *

Milling costs decreased from $2.03 to $1.90. * * *

The total net increase, exclusive of development costs for the year is 22.49 cents. Development not otherwise absorbed cost 58.51 cents per ton. The total costs, including taxes, litigation, depreciation, and development, is $6.68 per ton.

Compared with the average price of ore mined, $7.94 gross, per ton, referred to in a previous paragraph, the necessity of economy is very apparent.

The Gold Road mine was closed in 1918 to await the return of more favorable operating conditions. The company[18] operating this mine reports:

There are developed and ready for extraction approximately 60,000 tons of gold ore (of an average assay value of $12.50 per ton) with indicated small profit per ton at prevailing high costs. The mine possesses possibilities of new ore bodies in hitherto unexplored sections.

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[16] Excerpted from an article presented at the Chicago meeting of the Am. Inst. Min. and Met. Eng., Sept. 22–26, 1919; see Eng. and Min. Jour., vol. 108, p. 617, Oct. 11, 1919.

[17] Tom Reed Gold Mines Co. Twelfth Ann. Rept., for year ending Apr. 1, 1920.

[18] United States Smelting, Refining & Mining Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1919.

Wallapai district (*Chloride and Kingman*).—Twenty-one producers reported an output of 3,352 tons of ore and old tailings, from which were recovered $18,045 in gold, 44,531 ounces of silver, 90,990 pounds of copper, and 504,095 pounds of lead, valued in all at $111,651. The bulk of the ore, or 1,911 tons, was of smelting grade and contained 849.93 ounces of gold, 40,874 ounces of silver, 10,412 pounds of copper, and 504,095 pounds of lead. The Emerald Isle copper property, which was equipped with an electrolytic copper plant, was cleaned up and closed in February, 1919. The equipment consisted of a 50-ton plant, containing crushers, acid leaching plant, and electrolytic precipitating plant. There was also some gold and silver bullion recovered from the 10-ton cyanide plant on the Bella Union property. Most of the output, which contained lead with some gold and silver, was shipped from the Arizona-Butte mine to a lead smelter in California. The 150-ton wet-concentration mill on this property was not operated in 1919. Development was continued in driving the transportation tunnel. Other producers were the Distaff, Copper Lead, Fountain Head, George Washington, Home Pasttime, J. C. Group, Jemison, Lucky Boy, Mohawk, Black Jack, Rico, Dorothy, and Kingman Zinc claims. Considerable money was spent in developing the Elkhart, Copper Age, Brunswick, and Schuylkill properties, but no reports were received as to the ore developed.

Weaver district.—Small quantities of gold continued to be recovered from specimen gold quartz mined in the district.

PIMA COUNTY.

Mine production in Pima County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	56	2,033,450	[a] $1,359	[a] 128,399	60,024,129	368,172	540,027	$15,031,000
1919	29	1,652,324	1,447	40,655	43,808,491	489,886	.....	8,221,324
Increase or decrease, 1919	−27	−381,126	+88	−87,744	−16,215,638	+121,714	−540,027	−6,809,676

[a] Includes placer production.

The total average value per ton of the ore produced by 29 mine operators in Pima County decreased from $7.39 in 1918 to $4.97 in 1919, and the gold and silver produced from the smaller shipments made the total ore mined average 3 cents a ton in gold and silver, against 6 cents in 1918. The total silver decreased in value from $128,399 in 1918 to $45,534 in 1919; the copper from $14,825,960 to $8,148,379; and the lead from $26,140 to $25,964. The value of gold increased from $1,359 in 1918 to $1,447 in 1919. No zinc was reported in 1919. The most notable decrease was in the output of copper from the low-grade disseminated ores produced in the Ajo district. Ore of shipping grade aggregated 95,786 tons and contained $1,300 in gold, 36,448 ounces of silver, 7,427,854 pounds of copper, and 436,563 pounds of lead, valued in all at $1,446,841, or an average of $15.11 a ton. At milling plants 14,005 tons of ore yielded 993 tons of concentrates, containing gold, silver, copper, and lead, valued in all at $76,779, or an average of $77.32 a ton.

Ajo district.—Prospecting and diamond drilling of the claims in the Little Ajo group was continued in 1919. All the mine output credited to the district in 1919 was from the New Cornelia mine.[19] Early in February orders for a curtailment of production were given out, and with the exception of a small increase in September, October, and November production was restricted for the remainder of the year, resulting in an output of 39,509,461 pounds of copper—29,640,211 pounds of electrolytic copper, 6,368,952 pounds of copper in cement copper shipped, and 3,500,298 pounds of copper in ore shipped. The statement for 1918 showed that the ores contained 46,950,139 pounds of copper—31,264,642 pounds in electrolytic copper, 10,990,666 pounds in cement copper shipped, and 4,694,831 pounds in ore shipped to the smelter. The annual report of the company gives the following:

> Construction of a 500-ton flotation mill to test the sulphide ore was completed and the mill was put into operation late in August. * * *
>
> This mill will probably continue this experimental work until about May 1 (1920).
>
> There were mined and delivered to the crushing plant during the year 1,542,533 tons of ore, averaging 1.488 per cent copper. The high banks on hills No. 1 and No. 2 have been eliminated, and the second cuts have been started on these hills. The high bank on No. 3 hill was shot late in the year. This single shot broke approximately 350,000 tons of ore. This ore continues to break very coarse. We find on the 30-foot benches that the proportion of large chunks is not as great as it was on the high banks, and it will not be necessary to do so much of secondary blasting. * * *
>
> There were mined and shipped to Douglas from the high-grade ore body on the Southern claim 61,291.99 tons and 828 tons from the open mine workings, or a total of 62,119.99 tons, averaging 3.43 per cent copper. This tonnage was mined from the glory hole workings at a depth of 50 feet, and from the underground workings on the 250-foot level. There were also mined and delivered to the experimental concentrating plant 14,024.5 tons of sulphide ore, averaging 1.313 per cent total copper, containing 1.275 per cent copper as sulphides and 0.038 per cent copper as oxides. A total of 5,379 feet of drilling and raising in developing the ore body was accomplished during the year. Of this work 2,616 feet was done in drifting and developing the low-grade sulphide ores for the experimental concentrating plant.
>
> The diamond drilling being conducted on the southwest side lines of the developed ore body and started in 1918, was continued into this year. Five holes were completed, a total of 1,900 feet was drilled, and 1,085,356 tons of sulphide ore, averaging 1.25 per cent copper, were developed. No carbonate ores were developed in this drilling, as the carbonate capping averaged less than 0.6 per cent copper.

Amole district.—The Isabell group, operated by the Bonanza Park Mining Co., shipped lead ore, containing copper and silver. Beginning in February, the Arizona-Tonopah Mining & Milling Co. developed its property considerably, but no production was reported. The Arizona-Tucson property was also developed.

Arivaca district.—Small shipments of copper ore containing silver were made from the Arizona claim to the smelters at El Paso, Tex., and Douglas, Ariz.

Baboquivari district.—The Beach Mines (Inc.), developed its property in 1919, but no ore was shipped.

Cababi district.—The Pocahontas claim produced a little ore shipped by a lessee in 1919.

Empire district (*Pantano*).—The Forty-nine mine and the Verde Queen claim produced lead ore containing silver, copper, and gold.

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[19] New Cornelia Copper Co. Ann. Rept. for year ending Dec. 31, 1919.

Greaterville district.—No gold was reported to have been produced in this district in 1919, although small quantities may have been recovered by Mexican operators. The operator of the Quebec mines reported that a custom plant for concentration of ores was under construction early in 1920, and at that time ore was being stored for treatment.

Helvetia district.—From seven properties 3,357 tons of ore, all of smelting grade, was shipped, containing $300 in gold, 5,479 ounces of silver, 414,370 pounds of copper, and 58,432 pounds of lead, valued in all at $86,607, or an average of $25.80 a ton. Most of this ore, which was sulphide ore and contained copper and silver, was shipped from the Narragansett property. Considerable ore was also mined by the Rosemont Development Co., and some lead ore from the Omega and Good Friday mines was shipped in 1919.

Old Baldy district (Continental).—Copper ore containing silver, most of which was sulphide ore, was shipped from the property of the Old Hickory Copper Co., which was being developed.

Papago district.—Lead ore from this district containing silver and gold, with a little copper, was treated in a portable concentrating plant operating on ores from the Banner and Olympia mines, and concentrates were shipped to El Paso.

Pima district (Twin Buttes).—Seven producers from this district reported 4,542 tons of ore, all of smelting grade, containing $432 in gold, 14,986 ounces of silver, 1,004,851 pounds of copper, and 50,194 pounds of lead, valued in all at $206,778, or an average of $45.53 a ton. The largest shipments of ore were from the Queen mine, which produced sulphide copper ore containing silver. Similar ore was shipped from the Glance property and smaller quantities from the Plumed Knight and Paymaster properties.

Silver Bell district.—Shipments consisting largely of copper ores were made by five producers in 1919, aggregating 25,082 tons, containing $264 in gold, 9,787 ounces of silver, 2,489,634 pounds of copper, and 10,042 pounds of lead, valued in all at $474,830, or an average of $18.93 a ton. The larger part of the ore came from the Imperial mine. The El Tiro mine was also a steady producer in the hands of lessees, who have the property in charge for five years. As the property is on the railroad and well equipped, it has been in a position to produce copper at a much lower cost than most of the other small producers. Shipments were also made from the Atlas, Handy, and Stump mines, the Stump shipping lead ore containing silver.

PINAL COUNTY.

Mine production in Pinal County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	
1918	34	3,637,119	[a] $154,627	[a] 690,687	98,598,140	3,854,756	$25,472,743
1919	28	2,029,526	112,093	592,531	63,676,619	1,314,836	12,689,265
Decrease, 1919	6	1,607,593	42,534	98,156	34,921,521	2,539,920	12,783,478

[a] Includes placer production.

Most of the ore produced in 1919 came from the Ray mines. The total average value per ton decreased from $7 in 1918 to $6.25 in 1919, but the gold and silver value in this ore increased from 23 to 38 cents a ton. Nearly all the ore, or 2,006,902 tons, was of concentrating grade and produced 156,906 tons of concentrate, most of which was copper concentrate, there being only a small quantity of lead concentrate and copper-lead concentrate shipped. The ores of smelting grade, shipped directly to smelters, aggregated 22,624 tons and contained 1,625.92 ounces of gold, 162,541 ounces of silver, 5,373,015 pounds of copper, and 1,218,831 pounds of lead, valued in all at $1,279,636, or an average of $56.56 a ton. In 1918 the shipments of smelting ore aggregated 81,404 tons, valued at $3,255,866, or an average of $40 a ton. No placer bullion was reported in 1919.

Bunker Hill district.—Four producers reported 196 tons of ore, containing $167 in gold, 1,460 ounces of silver, 48,622 pounds of copper, and 24,452 pounds of lead, valued in all at $12,142, or an average of $61.95 a ton. All this ore was shipped directly to the smelter and was reported as largely sulphide ore, and most of it came from the property operated by the Magma Chief Copper Co. Smaller quantities of copper-lead ore came from the claims of the Bunker Hill Copper Co.

Butte district (Florence).—Copper ore was shipped from the Red Hills, Tharp, and Half Moon properties.

Casa Grande district.—One car of copper ore was shipped from the Andrade claim, and a small quantity of lead ore from the Red Chief property. Some development work in the way of churn drilling was performed on the Lake Shore property, and a two-compartment shaft was sunk 125 feet on the Silver Reef property.

Mineral Creek district (Ray and Kelvin).—A recent publication [20] describes the geology and the enriched disseminated ore deposits of this district. The Ray Consolidated property continued to be the largest producer of low-grade copper ores, and shipments of concentrate were made to the Hayden smelter. There was also a large output of copper concentrate containing silver from the Arizona Hercules milling plant,[21] and smaller quantities of crude smelting ore were shipped from the Copper Butte and McCallam properties. The output of the Ray Silver-Lead property, shipped to El Paso, Tex., consisted of oxidized lead ore containing silver and gold.

Operations were curtailed at the Ray Consolidated mines [22] to about half the normal output. The production of ore was 1,648,174 tons averaging 1.83 per cent of copper, against 3,476,749 tons averaging 1.65 per cent of copper in 1918. The net output of copper in 1919, after allowing for smelter deductions, was 46,011,371 pounds, against 83,599,160 pounds in 1918. Since April, 1911, the total output is 530,320,931 pounds of copper from all sources. Dividends amounting to $23,835,441.67 have been paid to stockholders since the incep-

[20] Ransome, F. L., The copper deposits of Ray and Miami, Ariz.: U. S. Geological Survey Prof. Paper 115, 192 pp. 1919.

[21] For description of mill see Shimmin, J. T., Eng. and Min. Jour., vol. 107, pp. 1117–1120, June 28, 1919; also the remodeled plant, vol. 109, pp. 1115–1117, May 15, 1920.

[22] Ray Consolidated Copper Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.

tion of operations and include $3,154,358 paid in 1919. The following paragraphs are taken from the annual report of the company:

The mining of carbonate ore from the surface was entirely suspended early in the year, only 916 tons of this product, averaging 5.34 per cent copper, being shipped during the first quarter of the year, as compared with 47,869 tons shipped during the year 1918. The total tonnage of carbonate and selected ore shipped to the smelter direct consisted of 5,822 tons, averaging 6.221 per cent copper. The shipment of concentrating ore to the mill at Hayden consisted of 1,642,352 tons of ore averaging 1.814 per cent copper.

The necessity of a reduced tonnage output from the mine during the year compelled the suspension of mining operations in some of the producing sections. In effecting this reduction it was found more economical to cease operations in the lower grade areas and confine activities to the higher grade ones. * * *

The mining cost for the year was $1.68 per ton, as compared with $1.76 for the previous year; of this year's cost, $0.051 per ton was due to coarse crushing and loading, leaving the net mining cost $1.63. The caving system of mining can not be used on the higher grade ore body at No. 3 shaft, and the more expensive square set and close filling method is used. Eliminating these costs, the net mining cost is $1.60. * * *

The total ore milled for the year was 1,621,600 dry tons, corresponding to a daily average of 4,443 tons, as compared with 3,411,000 dry tons during 1918. The total amount of ore milled since the beginning of operations and to the end of 1919 was 21,815,200 tons, averaging 1.678 per cent copper. The average grade of the ore milled for 1919 was 1.814 per cent copper, as compared with 1.613 per cent for 1918. The average recovery was 79.45 per cent of the entire copper content, equivalent to 28.83 pounds of copper per ton, as compared with 74.92 per cent or 24.17 pounds of copper per ton for the previous year.

The concentrate production for the year was 115,840 tons containing an average of 20.18 per cent copper. * * *

The recovery of copper occurring in the form of sulphides was 90.12 per cent, while the recovery of carbonates and other oxidized minerals, which are not readily amenable to water concentration, was 32.29 per cent. Experiments are being continued on the development of a method for increasing the extraction of these oxidized minerals.

The cost of milling for the year was $1.29 per ton as compared with $1.01 for the previous year. This increase was due in large part to the fact that the mill was operated at only half capacity. * * *

The average operating cost per pound of net copper produced from milling and direct smelting ore for the year was 15.62 cents. This cost does not include Federal income and profits taxes, for which no reserves were established in 1919, and does not take into account any credits for the value of the gold or silver or for the miscellaneous earnings incidental to the year's operations. The cost for the previous year, reduced for comparative purposes by the charge of 1.58 cents per pound for Federal tax reserves set up in 1918, and before applying credits for gold and silver and miscellaneous income, was 16.12 cents per pound of copper. The credits for gold and silver and for miscellaneous income for the current year are 0.68 cents, as compared with a similar credit of 0.50 cents for 1918.

Old Hat district (*Oracle and Schultz*).—The Dripping Springs Copper Co., operating the Pearl and Sunset properties, shipped to the smelters copper and lead ores containing silver. The lead ore shipped contained 30 ounces of silver a ton and 16 per cent of lead. The copper ores assayed from 2 to 8 ounces of silver a ton and 4 to 9 per cent of copper. At the Mammoth mine the St. Anthony Co. did considerable development work and shipped a small quantity of lead concentrate containing copper and silver. The concentrate, probably from previous operations, was treated at a chemical plant near Los Angeles.

Pioneer district.—Eleven producers reported 96,933 tons of ore, of which 83,314 tons was of milling grade, and 13,619 tons was shipped directly to the smelter. The total metallic content of the

concentrates and ore shipped to the smelter was $95,142 in gold, 519,334 ounces of silver, 10,549,028 pounds of copper, and 42,542 pounds of lead, valued in all at $2,641,170. There were three chief producers, the Magma Copper, Silver King, and Superior & Arizona. Considerable development work was done on the Grand Pacific property, which is 2 miles south of the Magma mine.

In 1919 the Magma mine [23] produced 89,156 tons of ore. Of this output, 12,948 tons was hand sorted crude sulphide ore shipped directly to the smelter, averaging 0.1091 ounce of gold and 11.81 ounces of silver a ton and 16.49 per cent of copper. From 76,208 tons of milling ore 27,555 tons of concentrate were made, containing 0.1148 ounce of gold and 10.37 ounces of silver a ton and 10.99 per cent of copper. The average assay of the mill tailing was 0.382 ounce of silver a ton and 0.276 per cent of copper. The following paragraphs are taken from the company's report:

> The mill recovery was 95.74 per cent of the total copper in the mill heads. The total copper recovered, including ore obtained by hand sorting, was 97.46 per cent of the copper content of the run of mine ore.
>
> The net production, after deducting all smelter and refining losses, was 9,698,902 pounds of copper, 416,773.17 ounces of silver, and 4,576.602 ounces of gold. * * *
>
> The net production to date (end of 1919), after deducting all smelting and refining losses, has been 53,095,053 pounds of copper, 2,622,831 ounces of silver, and 22,688 ounces of gold. * * *
>
> The development work done during 1919 has given exceptionally good results and increased ore reserves both laterally and with depth.
>
> Work on the lower levels underneath the old zinc-silver ore shoot, developed on the 1,200 and 1,300 levels, shows increasing amounts of copper in the form of chalcopyrite and bornite, replacing the zinc values as found directly above. In addition to this, lower levels show good ore in portion of vein which was not mineralized directly above on the 1,200 and 1,300 levels. During the year the ore body on the 1,400 level was increased 205 feet in length, averaging 5.8 feet in width and assaying 10.77 per cent copper, 4.8 ounces of silver, and 0.035 ounce gold.
>
> On the 1,500 level the main ore body was increased 310 feet in length, showing an average width of 12.1 feet and assaying 4.88 per cent copper, 2.1 ounces silver, and 0.02 ounce gold. Considerable crosscutting was done in the eastern portion of the mine on the 1,500-foot level. This work indicates that there is 1,200 feet of low grade ore which will probably average 5 feet in width and assay 1.71 per cent copper, 6.1 ounces silver, and 0.025 ounce gold. Although this low-grade ore is not included in present ore reserves it may prove a valuable future asset to the company. * * *
>
> On the 1,600 level the size of the ore body was increased so that we now have 1,000 feet of continuous ore, which will average 12 feet in width, and assay 6 per cent copper, 3.2 ounces silver, and 0.04 ounce gold.
>
> The 1,700 level now shows 660 feet of ore, averaging 6.2 feet in width and assaying 10.2 per cent copper, 5.1 ounces of silver, and 0.04 ounce gold. * * *
>
> On the 1,800 level there is 800 feet of ore, averaging 13 feet in width, and assaying 5.05 per cent copper, 2.6 ounces silver, and 0.01 ounce of gold. The last crosscut on this level showed 39.5 feet of ore assaying 3.82 per cent copper and 1.3 ounces silver, the copper values being due to the presence of chalcopyrite and bornite, so that there is no doubt but what the ore body on this level will be increased in length.
>
> During the year diamond drill hole 1,805 was put down below the 1,800 level. This hole passed through the vein at an elevation approximately equivalent to the 2,150 level, and developed 19 feet of ore which assays 5.42 per cent copper and 2.4 ounces silver. * * *
>
> The new No. 3 shaft was entirely completed down to 82 feet below the 2,000-foot level. A station was cut on the 2,000-foot level, and a main crosscut has been driven for 497 feet toward No. 2 shaft. * * *

[23] Magma Copper Co. Ann. Rept. for year ending Dec. 31, 1919.

During the year we drove a lower main tunnel. This tunnel is at the same elevation as the 500 level and connects with all three shafts, the distance from No. 3 shaft to the portal being 1,628 feet. Ore bins are being erected at the portal and on the narrow-gage railroad. Through this tunnel will be handled all direct-shipping ore and supplies to the mine.

Priorwood district.—Copper ore containing gold and silver was shipped to the smelter from the Antelope Peak copper property.

Riverside district.—The Gila Development Co. built a small mill for the treatment of free-milling gold ores. It was expected to be in operation in January.

SANTA CRUZ COUNTY.

Twenty-three producers in Santa Cruz County reported 24,801 tons of ore in 1919, or 79,394 tons less than was reported by 41 producers in 1918. In 1919 the ore sold or treated contained $3,477 in gold, 223,241 ounces of silver, 1,192,656 pounds of copper, and 1,078,228 pounds of lead, valued in all at $532,487, or an average of $21.47 a ton. The ore produced in 1918 was valued at $1,813,974, or an average of $17.41 a ton. Ore of shipping grade amounted to 13,408 tons and contained $3,477 in gold, 218,540 ounces of silver, 916,869 pounds of copper, and 934,239 pounds of lead, valued in all at $468,295, or an average of $34.93 a ton. At milling plants 966 tons of lead concentrate and copper concentrate containing silver were made, valued at $58,995, or an average of $61.07 a ton.

Harshaw district.—Eight producers reported the output of 5,022 tons of ore, containing $1,976 in gold, 135,618 ounces of silver, 36,037 pounds of copper, and 412,673 pounds of lead, valued in all at $182,443, or an average of $36.33 a ton. Of the ore produced 3,999 tons was of shipping grade and contained 95.60 ounces of gold, 133,112 ounces of silver, 36,037 pounds of copper, and 268,684 pounds of lead. There was also 1,033 tons of ore milled, producing 256 tons of concentrates containing lead and silver. The principal producers of shipping ore were the Black Eagle and World's Fair mines. Some ore was concentrated at the milling plant on the Flux property.

Nogales district.—Ore of shipping grade, containing principally copper and silver with a little gold, was produced from the Arizona European property.

Palmetto district.—In 1919 the Three R. property, which has been a steady producer in the last few years, was sold in December to Magma Copper Co. interests, to be operated under the name of the Patagonia Superior Copper Co. Up to the time the property was acquired by the new company it produced considerable copper ore, most of which was milled.

Patagonia district.—The output in 1919 of 9,203 tons of ore from 8 producers was all of smelting grade and contained $1,362 in gold, 83,176 ounces of silver, 787,896 pounds of copper, and 656,498 pounds of lead, valued in all at $275,862, or an average of $29.98 a ton. Most of the ore produced was mined by lessees from the Duquesne property, which yielded sulphide copper and lead ores. Similar ore was shipped from the Pride of the West and Mowry mines. For several years the operators of the Duquesne properties have shipped ore to the Douglas smelters by hauling it from the mine to Zorillo, a station on the Southern Pacific Railroad in Mexico.

Tyndall district.—Only 66 tons of ore was reported as shipped from the Tyndall district in 1919. The Bland mine produced a little oxidized lead ore, and copper-lead ore was shipped from another property by lessees.

Wrightson district.—Three producers in this district reported an output of 64 tons of ore, containing mostly copper and some silver. The principal producers were the Posey and Ivanhoe properties.

YAVAPAI COUNTY.

Mine production in Yavapai County, Ariz., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	93	1,301,828	$1,117,701	2,502,968	148,882,695	348,389	357,380	$40,451,953
1919	79	738,221	614,968	1,252,894	80,227,549	237,605	1,717,000	17,078,467
Increase or decrease, 1919	−14	−563,607	−502,733	−1,250,074	−68,655,146	−110,784	+1,359,620	−23,373,486

[a] Includes placer production.

The value of the ore produced in Yavapai County decreased from $31.07 a ton in 1918 to $23.13 in 1919, and the gold and silver value in this ore from $2.78 a ton to $2.73. Of the total value of the metals reported, $614,968 was for gold, $1,403,241 for silver, $14,922,324 for copper, $12,593 for lead, and $125,341 for zinc. Compared with that of 1918, the output of all metals, except zinc, was considerably less. First-class ore shipped to various smelters aggregated 624,294 tons. Most of the shipments consisted of copper ores (603,527 tons), of which 601,804 tons was sulphide ore and 1,723 tons oxidized copper ore. The total value of the smelting ores was $15,994,727, or an average of $25.62 a ton. The dry or siliceous ore produced amounted to 21,723 tons, mostly siliceous gold and silver ore, the larger part of which was treated at smelting plants. Concentrates amounting to 35,181 tons, derived from 110,701 tons of ore, were smelted and contained $71,856 in gold, 101,152 ounces of silver, 4,468,283 pounds of copper, and 99,495 pounds of lead, valued in all at $1,021,520, or an average of $29.04 a ton. The placer output amounted to $2,083 in gold and 16 ounces of silver, against $2,191 in gold and 14 ounces of silver in 1918.

Agua Fria district.—There were three producers of ore in this district in 1919, of which the Binghampton was the largest. The ore is treated in the concentrating mill on the property and copper concentrate is shipped to the smelter at Humboldt, but after March shipments ceased.

Big Bug district.—Although 11 producers of ore and placer bullion were reported in 1919, only two deep mines were important shippers—the Blue Bell, near Mayer, and the Arizona National, near Humboldt. The ores from the Blue Bell contained principally copper, which was recovered as concentrate at the milling plant of the Humboldt smelter. The ores of the Arizona National property,

which contain lead and silver with some copper and gold, were treated by flotation and table concentration. Shipments of copper ore of smelting grade, containing silver and gold, were made from the Henrietta mine. This property shipped only during the first half of January and carried on small development work during the remainder of the year. Some old tailing, containing silver and gold with a little copper, was shipped from the Gladstone mine. Other shippers of note in the district were the Silver Bell and Little Egypt. A small production of placer gold was reported by one operator in the district during 1919.

The Blue Bell mine [24] in 1919 produced 122,069 tons of ore containing $2.82 in gold and silver a ton and 2.58 per cent of copper. The following paragraphs are taken from the company's report:

The grade of ore in copper was exceptionally low and represented a lower grade than the average of ore remaining developed in the mine. Certain conditions made it necessary to work out this low-grade ore, and we were also unfortunate in encountering several faults in the bigger stopes and in suffering from falls of wall rock, which seriously contaminated the grade of ore drawn from the chutes.

In spite of every effort to economize, a continued increase was noted and the average cost of all Blue Bell ore f. o. b. Humboldt was $4.0063 per ton. * * *

The Blue Bell mine has produced during the past seven years a total of 606,023 tons of ore. The total production of the mine since it was originally opened in 1896 has probably been close to 800,000 tons. * * *

Appended is a table giving in detail the results of work during the past seven years.

Operations at Blue Bell mine, 1913–1919.

Year.	Development and exploration work.				Ore produced.					Estimated ore reserves at end of year.
	Feet.	Cost per ton of ore produced.	New ore developed.		Tons.	Gold and silver.	Copper.	Cost.	Total cost.	
			Tons.	*Cost per ton.*		*Average value.*	*Percent.*	*Per ton.*	*Per ton.*	*Tons.*
1913	1,299	$0.254	66,292	$0.141	36,792	$1.60	3.758	$2.73	$3.350	154 000
1914	1,411	.210	54,000	.218	56,058	1.40	3.637	1.81	2.380	152,000
1915	2,743	.273	165,000	.135	82,171	1.40	2.970	2.00	2.629	235,000
1916	4,819	.842	319,570	.198	75,070	1.70	3.278	2.37	3.565	479,500
1917	3,676	.577	160,073	.370	102,773	2.40	3.176	2.42	3.350	536 800
1918	4,638	.588	69,290	1.110	131,090	2.80	2.771	2.82	3.786	470.000
1919	2,821	.214	42,069	.622	122,069	2.82	2.582	3.38	4.006	390,000

At the end of the year it is estimated that there were 390,000 tons of ore developed as positive, highly probable, and probable. Of this tonnage, 54,548 tons were broken in the stopes.

Black Canyon district.—The Brooks and Cutter claims were producers of ore, the latter having considerable silver in addition to some lead.

Black Hills district.—The Yaeger Canyon property, operated by the Shannon Copper Co., was the producer of a small quantity of copper ore taken out in the development of the property. A small shipment was also made from the Red Bird claim.

[24] Consolidated Arizona Smelting Co. Ann. Rept. for year ending Dec. 31, 1919.

Black Rock district.—A small production of copper ore from one property, and some gold recovered from concentrates comprised the output of this district in 1919.

Copper Basin district.—Copper ore containing silver and gold was produced from the Copper Basin and Senator properties and also from the Grub mine. The output of the district aggregated 3,497 tons.

At the Copper Basin mine [25] operations were suspended January 8 and not resumed during the year. Shipments from the Copper Basin group amounted to 2,264 tons of ore, containing 112,795 pounds of copper. From the Senator mine shipments consisted of 832 tons of ore, containing 28.79 ounces of gold, 6,164.76 ounces of silver, and 129,118 pounds of copper. In addition lessees shipped 234 tons of ore.

Eureka district.—With a good road between its mine and the railroad shipping point, the Copper King mine was operated continuously and produced sulphide zinc ore, which was shipped to a zinc plant in Arkansas.

Hassayampa district.—The output of 12 deep mines and 1 placer amounted to $9,872 in 1919. There were 359 tons of ore, most of which, or 253 tons, was milled and yielded gold and bullion and some concentrate containing gold and silver. Ore shipped directly to the smelters amounted to 106 tons, containing principally silver, with some lead, copper, and gold. Most of the milling ore was from the Midnight Test, Crook, and Climax properties. Only small shipments were made from other properties in the district. Very little placer gold is produced in this district, and only one operator had a production in 1919.

Martinez district.—In cleaning up around the old milling plants and tailing dumps of the Congress Consolidated property some gold and silver was recovered by lessees.

Peck district.—The De Soto mine was the largest producer in the Peck district. The ore was shipped to the milling plant at Humboldt, Ariz., and produced concentrate containing copper, silver, and gold. Shipments of silver ore were made from the Swastika and Silver Tip groups. Some development work was carried on at the North Extension of the Swastika property in the driving of a tunnel, which is to intersect the vein system at 400 feet in depth.

From the De Soto mine [26] 27,067 tons of ore was produced, which contained $2.23 in gold and silver a ton and 2.35 per cent of copper. The annual report of the company says:

> The total expense of exploration and development was $17,284.38, representing $0.6385 per ton of ore shipped. One thousand four hundred and seventeen feet of diamond drilling were carried out, at a cost of $2.175 per foot; also 1,167 feet of drifts and crosscuts, at an average cost of $12.17 per foot.
>
> This work did not result in finding any new ore bodies, but enlarged to some extent the limits of the ore bodies which were already known. On the whole the result was disappointing, and we now feel that the De Soto ground has been as thoroughly explored as conditions justify and the chance of finding new ore does not warrant any further expense under present conditions.
>
> Development and exploration work has been discontinued from the first of the present year and the mine may be considered as completely developed and will be worked out gradually and in accordance with market conditions.

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[25] Phelps Dodge Corporation Ann. Rept. for year ending Dec. 31, 1919.
[26] Consolidated Arizona Smelting Co. Ann. Rept. for year ending Dec. 31, 1919.

Th estimate of ore reserves, including positive, highly probable, and probable ore, as of January 1, 1920, is 21,000 tons, the average content being $2.30 value in gold and silver and 2.15 per cent copper. In addition to the above tonnage there is a very considerable quantity of low-grade material which will average approximately $1.50 in gold and silver and 1.75 per cent copper. This is not estimated as ore at present, since it can not be treated with profit under existing market conditions, but should the price of copper exceed 25 cents per pound it would automatically become commercial ore and provision to mine and treat same would then be made. No figure can be put on the tonnage of this material, as it is variable rather than a constant quantity, depending entirely upon the market price. * * *

The costs of production have increased because of general conditions and also because of the lower tonnage produced during the past year and because much of the ore came from narrow veins in which the stoping costs were necessarily extremely high. Our cost last year, including exploration and development, was $4.746 per ton f. o. b. Humboldt, Ariz. The actual mining and transportation cost was $4.10 per ton, and during 1920 we hope to approximate this last figure, since no exploration nor development work will be carried on.

Operations at De Soto mine, 1914–1919.

Year.	Development and exploration work.				Ore produced.					Estimated ore reserves at end of year.
	Feet.	Cost per ton of ore produced.	New ore developed.		Tons.	Gold and silver.	Copper	Cost.[a]	Total cost.[b]	
			Tons.	Cost. per ton.		Average value.	Per cent.	Per ton.	Per ton.	Tons.
1914										32,000
1915		$0.7200	41,360	$0.132	8,360	$1.50	3.50	$3.20	$4.633	65,000
1916	1,814	.5030	72,800	.237	34,382	1.58	3.37	2.35	3.558	103,500
1917	532	.1340	7,183	.830	44,483	2.23	3.03	2.31	3.150	66,200
1918	875	.3954	9,670	1.750	42,870	2.70	2.57	2.50	3.685	33,000
1919	2,584	.6385	15,000	.870	27,067	2.23	2.35	2.46	4.746	21,000

[a] Cost of production, excluding development and freight.
[b] F. o. b. Humboldt, Ariz.

Pierce district.—The Liberty Bell group, in the Harcuvar Mountains 12 miles northwest of Aguila, yielded a small quantity of copper ore with low content of gold and silver. A small shipment of similar ore was also made from the Sunday group.

Pine Grove district.—Ore of shipping grade produced from the Union mine contained copper, silver, and gold, and milling ore of similar character produced from the Wildflower property was treated at a concentration mill in the district.

Silver Mountain district.—A small quantity of ore from the Monte Carlo property was treated in an arrastre.

Tiger district (*Crownking*).—From the Cougar claim silver ore containing copper and gold was shipped to the smelter at Humboldt. This shipment was taken out during development, and was shipped to the smelter together with some silver ore from the Cobalt, Lida, Lincoln, Tiger, and Springfield properties.

Tip Top district.—In opening the Tip Top Heath property a small shipment of silver ore was made to an ore purchaser at Mayer, Ariz.

Turkey district (*Venezia*).—Some lead ore containing silver was shipped from the War Eagle property to El Paso, Tex., and silver ore from the Bill Arp mine was shipped to the smelter at Humboldt.

Verde district (Jerome).—Four properties in this district produced 566,445 tons of ore, all of which except 100 tons yielding gold and silver bullion was treated at smelting plants at Clarkdale. From the ore produced there was recovered $437,144 in gold, 949,436 ounces of silver, and 72,332,704 pounds of copper, valued in all at $14,954,395, or an average of $26.40 a ton. Two mines, the United Verde and United Verde Extension, produced the bulk of the ore, and a small quantity was mined from the Jerome Verde property. The Hayden Development Co., operating a gold mill in the district, was succeeded by the Copper Chief Mining Co.

The United Verde Copper Co.[27] has started its long-planned attack upon the old burning sulphide stopes which have been smoldering for more than 20 years and have defied all efforts to extinguish them. The plan is to use enormous steam shovels to remove the ready-made calcines, which will be hauled in steel-hopper broad-gage cars and dumped direct into the reverberatories at the company's smelter at Clarkdale. The shovels already are at work excavating for the new mine power plant and surface building, and 14,000,000 cubic yards of material will be gouged out of the face of the Black Hills Range. All waste will be used to fill ravines. A winding railroad has been built on a 4 per cent grade up the mountain. This road has been under construction for two years and a half, and in addition to serving the mine will serve the people of Jerome. At Clarkdale the United Verde smelter has already doubled its capacity, though the improvements are not yet complete. Six reverberatory furnaces of larger type than those now in use have been added. Twelve new roasters of greater capacity than the old ones have been built. Other improvements include installation of two Great Falls converter stands and eight new Sterling boilers. Two special features worthy of mention are the use of powdered coal as fuel for reverberatories in place of fuel oil, which of late has proved very expensive. Gallup semibituminous coal is stored under water until needed, as it is susceptible to spontaneous combustion. Before using it is crushed, dried, and then pulverized until it can be sifted through a 100-mesh screen. It is then ready to be taken by air blast and blown into the 100-foot reverberatories. A smoke-treating plant operated under 125,000 volts catches and deposits all metal particles. The smoke-treating plant will cost $75,000, but great results are expected from it.

The United Verde Extension mine[28] in 1919 produced 93,325 tons of copper ore of smelting grade, yielding 28,860,615 pounds of copper, 272,855 ounces of silver, and 3,169 ounces of gold. The copper on hand January 1, 1919, at the smelting plant of the company was reported to be 19,206,954 pounds, and the quantity sold in 1919 was 20,847,156 pounds, disposed of at an average price of 17.136 cents a pound. At the end of 1919 the copper on hand was 27,220,393 pounds. Ore reserves above the 1,400 level are estimated to be 571,400 tons, averaging 15 per cent of copper, 0.025 ounce of gold, and 3 ounces of silver. The cost of copper in 1919 was 9.8 cents a pound, including the cost of mining 4.3 cents, smelting 2.5 cents, freight on ore 0.2 cent, freight on bullion and refining 2.6 cents, and outside

[27] Min. and Sci. Press, vol. 119, p. 931, Dec. 27, 1919.
[28] United Verde Extension Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

expenses 0.2 cent. These average costs do not include depreciation, depletion, or taxes. The following is taken from the company's annual report:

> The drift south from the Audrey shaft on the 1,500-foot level is about to enter the ore body. The drift south on the 1,600 level will reach the ore body in March. Driving the drift south on the 1,700-foot level will begin shortly.
>
> Crosscuts from the Audrey shaft to the Edith shaft have been completed on the 1,500-foot level, 1,600-foot level, and 1,700-foot level, and the Edith shaft is being opened to the lowest level.
>
> The sump and pump stations on and below the 1,700-foot level have been completed. Ore pockets from the 1,100 and 1,200 foot levels for storage and transfer to the haulage tunnel on the 1,300-foot level have been completed and are in operation.
>
> In the haulage tunnel 1,233 feet of tunnel work and connections have been made during the year, completing this work. This now makes a total of 12,395 feet of standard-gage-track tunnel and 332 feet of connections. Transportation of the ore is now made by this tunnel by electric haulage with 25-ton locomotive and 30-ton cars. * * *
>
> On account of the unfortunate strike in the mines of the district, smelting operations were forced to suspend for four months of the year. The smelter employees were engaged in necessary improvements to the furnaces and in change of location of the waste-heat boilers, as well as grading for town site. Smelting operations were resumed on June 9. One reverberatory was run most of the time alternating with the blast furnace for a short period

Walker district.—One shipment of concentrate containing gold and silver, with some lead and copper, was made from ore milled from the Black Diamond property. Operations along Lynx Creek, by placer operators, resulted in the production of a small quantity of gold.

Walnut Grove district (Kirkland).—The McMahon group was operated during part of the year and some copper ore was shipped to Douglas, Ariz. Shipments were also made from the Zonia property and some gold ore from the Kilgore and Brady groups.

Weaver district.—It is estimated that about 50 ounces of gold was produced from the dry placers in the vicinity of Octave in 1919.

YUMA COUNTY.

Twenty-one deep-mine operators in Yuma County in 1919 reported the output of 26,129 tons of ore, which was 7,810 tons less than was reported by 43 producers in 1918. The average value of this ore decreased from $18.71 a ton in 1918 to $8.44 in 1919 and the gold and silver value from $1.09 to 96 cents. The total value of the gold, silver, copper, and lead produced in the county was $221,639, against $636,085 in 1918. The placer production amounted to $965 in gold and 10 ounces of silver, against $1,100 in gold and 8 ounces of silver in 1918. Ore of shipping grade aggregated 4,933 tons, containing $15,506 in gold, 1,090 ounces of silver, 426,809 pounds of copper, and 28,134 pounds of lead. At gold and silver mills 50 tons of ore was treated, and produced 44.07 ounces of gold and 20 ounces of silver. Concentrates amounting to 1,452 tons, derived from 18,146 tons of ore and 3,000 tons of old tailings, contained $49 in gold, 6,491 ounces of silver, 487,690 pounds of copper, and 454,639 pounds of lead, valued in all at $122,125, or an average of $84.11 a ton.

Castle Dome district.—Three properties were the producers of 8,095 tons of ore and tailing, of which 5,068 tons was milled, yielding

354 tons of concentrate, containing 2.36 ounces of gold, 6,146 ounces of silver, and 454,639 pounds of lead. There was also 27 tons of ore shipped, containing lead and silver. Some old tailing re-treated produced lead concentrates. The principal work done was on the property of the Reorganized United Mines Co., the mill of which is equipped for dry concentration. The product recovered was shipped to smelters in Utah. The Chief of the Dome and Castle Mountain claims produced silver-bearing lead ore of shipping grade, and some lead concentrate was recovered from old tailing. Placer operators reported a small quantity of gold produced in 1919.

Cienega district.—Three producers in this district reported the production of 146 tons of ore, containing $2,544 in gold, 44 ounces of silver, and 38,042 pounds of copper, valued in all at $9,669, or an average of $66.43 a ton. Most of this ore was from the Carnation and Eagle properties, with some from the Billy Mack claim.

Ellsworth district.—Ten properties in this district produced 1,166 tons of ore, containing $12,843 in gold, 417 ounces of silver, and 198,211 pounds of copper, valued in all at $50,177, or an average of $43.04 a ton. The larger part of the ore came from the Bullard and Critic mines, each of which produced ore containing copper and considerable gold, which was shipped to the smelter. Other producers were the Copperopolis, Cuprite, San Marcos, Victor & Bell Crown, and Black Giant properties.

Planet district.—Considerable copper ore, containing a little silver, was made from the Clara mine, operated by the Swansea Lease (Inc.). Some of the ore was milled and produced copper concentrate, which, with the crude ore, was shipped to the smelters at Humboldt and Clarkdale. About 200 men were employed at the Swansea mine in December, and some good copper ore was opened on the 600-foot level of the mine. The flotation unit installed in the concentrator is reported to have given good results.

Plomosa district.—The dry placers of this district continued to produce occasional small quantities of gold. No large operations have been reported, although several attempts have been made to operate the placers on a big scale. The King placer, which is equipped with an electric shovel and dry concentrator, handled about 2,230 yards of material during 1919, producing some gold.

Silver district.—The Saxon group, at the north end of this district, produced a small quantity of lead ore containing silver, which was shipped to the smelter at El Paso, Tex.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEVADA.[1]

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

The great decrease in the mine production of gold, silver, copper, lead, and zinc in Nevada in 1919 is shown in the accompanying table; but in spite of adverse conditions, eleven mining companies in Nevada, some of which owned property in other States, paid dividends amounting to $4,307,867.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1918 and 1919.

Year.	Number of producers.		Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
	Placers.	Deep mines.							
			Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	54	660	6,472,579	$6,619,937	10,000,599	116,316,441	23,316,534	16,724,753	$48,528,124
1919	37	384	3,187,831	4,541,502	6,863,580	52,331,175	15,349,370	9,004,698	23,433,171
Decrease, 1919	17	276	3,284,748	2,078,435	3,137,019	63,985,266	7,967,164	7,720,055	25,094,953
Total, 1904–1919			56,019,307	172,699,579	173,104,565	912,516,487	200,275,171	161,717,023	483,054,513

[a] Includes placer production.

ORE.

The average value of ore per ton in all metals was $7.31, against $7.46 in 1918, but the value in gold and silver increased from $2.53 in 1918 to $3.79 in 1919. The largest decreases in production of ore were in White Pine, Lyon, Esmeralda, Nye, and Mineral counties. The output of dry or siliceous ores decreased from 1,394,583 tons in 1918 to 783,567 tons in 1919. The output of ores of this class in 1919 included 163,279 tons of low-grade siliceous gold ores, averaging $14.16 in gold and 0.63 ounce of silver a ton, and carrying small quantities of copper and lead. The output of mixed dry or siliceous ores of gold and silver in 1919 aggregated 68,874 tons and averaged

[1] Valuable assistance in the preparation of the report and the compilation of statistical tables was rendered by B. N. Patchell, of the United States Geological Survey.

per ton $8.55 in gold and 8.08 ounces of silver. Some of these ores contained small quantities of copper and lead. The output of siliceous silver ores in 1919 amounted to 551,414 tons, mined by 140 producers and averaging per ton $2.04 in gold and 10.24 ounces of silver, as against 839,879 tons mined in 1918 by 161 producers and averaging $2.12 in gold and 10.15 ounces of silver. A total of 91,053 tons of oxidized iron-manganese ore, which was produced entirely in the vicinity of Pioche, is included in the silver ore. This ore contained lead and small quantities of gold and silver and was particularly valuable as flux.

The production of copper, lead, and zinc ores is shown on page 375.

The output of lead ore of smelting grade amounted to 13,063 tons. The oxidized ore, largely carbonates, in this smelting ore decreased from 17,874 tons in 1918 to 10,392 tons in 1919 and averaged $4.38 in gold, 29.31 ounces of silver, 6.58 pounds of copper, 471.48 pounds of lead, and $63.42 a ton in total value. The sulphide lead ores of smelting grade amounted to 2,671 tons and averaged $1.53 in gold, 20.32 ounces of silver, 1.19 pounds of copper, 292.82 pounds of lead, and $40.03 a ton in total value. The output of zinc ores of shipping grade decreased from 10,977 tons in 1918 to 4,867 tons in 1919. They were all oxidized or carbonate ores and averaged 2.09 pounds of lead and 745.88 pounds of recoverable zinc per ton. The production of copper-lead ores increased from 800 tons in 1918 to 4,996 tons in 1919, of which 4,842 tons was concentrated into 101 tons of copper-lead concentrate. All the first-class ore, 154 tons, was oxidized or carbonate copper-lead ores, averaging $18.75 in gold, 8.85 ounces of silver, 72.77 pounds of copper, 363.18 pounds of lead, and having a total value of $61.46 a ton. There were 12,060 tons of lead-zinc ore produced, nearly all of which, or 11,398 tons, was concentrated into 2,351 tons of lead concentrate and 8,208 tons of zinc concentrate. The remainder was lead-zinc ore of shipping grade, all of which was oxidized.

The output of milling ores was 2,939,247 tons, of which 638,784 tons was treated either by amalgamation or cyanidation, and 2,300,463 tons by concentration, followed by smelting. The 578,746 tons of ore and 35,444 tons of tailings treated by cyanidation contained an average per ton of $4.71 in gold and 9.09 ounces of silver. The ores amalgamated (60,038 tons) yielded bullion averaging per ton $9.34 in gold and 0.28 ounce of silver.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1919.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	37	.....	6,399.43	2,374	.....	.....	.....
Dry or siliceous ore	253	783,567	194,008.03	6,306,583	191,763	5,987,127	.....
Copper ore	50	2,363,189	16,254.92	73,371	52,042,089	6,471	.....
Lead ore	84	19,152	2,481.11	373,518	71,862	6,121,663	.....
Zinc ore	11	4,867	.....	.....	.....	10,190	3,630,194
Copper-lead ore	7	4,996	511.52	3,345	24,871	92,413	.....
Lead-zinc ore	10	12,060	40.15	104,389	590	3,131,506	5,374,504
	.....	3,187,831	219,695.16	6,863,580	52,331,175	15,349,370	9,004,698

Ore sold or treated in Nevada in 1919, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	40,878	.....	14	.....	.....	.....	40,892
Clark	17,073	376	5,232	1,062	4,850	11,562	40,155
Elko	58,034	248	1,729	.....	.....	.....	60,011
Esmeralda	28,096	161	226	.....	.....	.....	28,483
Eureka	1,392	.....	2,036	.....	.....	.....	3,428
Humboldt	141	25	52	.....	.....	.....	218
Lander	340	2,003	2,520	.....	.....	.....	4,863
Lincoln	91,544	681	3,952	.....	.....	498	96,675
Lyon	24,036	85,862	.....	.....	.....	.....	109,898
Mineral	15,386	3,118	425	.....	.....	.....	18,929
Nye	340,511	43	214	.....	.....	.....	340,768
Ormsby	104	.....	.....	.....	.....	.....	104
Pershing	114,502	775	89	.....	.....	.....	115,366
Storey	50,376	.....	.....	.....	.....	.....	50,376
Washoe	189	48	.....	.....	.....	.....	237
White Pine	965	2,269,849	2,663	3,805	146	.....	2,277,428
	[a]783,567	2,363,189	19,152	4,867	4,996	12,060	3,187,831
Average value per ton in gold and silver	$14.13	$0.18	$24.52	.....	$2.87	$9.76	$3.79

[a] Includes 163,279 tons of gold ore, 68,874 tons of gold and silver ore, and 551,414 tons of silver ore. The last named includes 91,053 tons of oxidized iron manganese ore.

GOLD.

The gold produced at mines in Nevada in 1919 decreased $2,078,435 as compared with 1918. Nye County produced the largest output—$1,537,980, against $1,991,845 in 1918. Esmeralda County followed with $787,579, against $1,361,321 in 1918. The Goldfield district, which produced $472,307 less than in 1918, made most of this output. The counties whose gold output showed largest increases were Elko, Churchill, Lyon, and Lincoln. The largest decreases were in Esmeralda, Nye, Mineral, White Pine, and Storey counties. Placer gold was produced in greatest quantity in Nye and Lander counties, and the value of the total placer gold was $132,288, as against $218,380 in 1918. Ore was milled in 1919 by amalgamation in 10 counties and by cyanidation in 10 counties. From these two methods of treatment $3,455,920 in gold was produced from 638,784 tons of ore and 35,444 tons of old tailings. The total average recovery of gold from ore and tailings milled was $5.13 a ton. The gold extracted by amalgamation averaged $9.34 a ton of ore treated, as against $8.44 a ton in 1918, and by cyanidation it averaged $4.71 a ton of ore and tailings treated, as against $3.64 in 1918. From all concentrates, including siliceous, copper, lead, lead-zinc, and iron sulphide concentrates, 18,357.03 ounces of gold was produced, against 46,155.31 ounces in 1918. The gold in dry or siliceous concentrates was 993.49 ounces in 1919, against 1,552.96 ounces in 1918, 4,057.75 ounces in 1917, and 13,235.26 ounces in 1916. In each of these years the production of gold was principally from iron sulphide concentrates. The copper concentrates contained 16,830.08 ounces, against 43,580.87 ounces in 1918, and the lead concentrates 161.64 ounces, against 1,021.48 ounces in 1918.

Sixteen producers furnished more than 78 per cent of the total gold in 1919. These properties, which yielded more than 5,000 ounces each, were the Elkoro Mines, at Jarbidge; Goldfield Consolidated and Goldfield Development, at Goldfield; Nevada Consolidated Cop-

per, at Ely; Fairview Round Mountain, at Round Mountain; Florence, at Goldfield; White Caps, at Manhattan; Tonopah Belmont, at Tonopah; Elko Prince, at Midas; Tonopah Extension, at Tonopah; Olympic, in Mineral County; Consolidated Virginia, at Virginia City; Round Mountain Mining Co., at Round Mountain; Tonopah Mining Co., at Tonopah; West End, at Tonopah; Nevada Wonder, at Wonder; and Ophir Silver, at Virginia City.

Mine production of gold in Nevada in 1919, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill		5,816.13					5,816.13
Clark		6,460.61	28.44	8.75	496.50	22.15	7,016.45
Elko	1.98	34,052.68	4.50	9.22			34,068.38
Esmeralda		37,637.89	399.33	61.91			38,099.13
Eureka	27.57	473.16		593.56			1,094.29
Humboldt	43.34	723.99		10.49			777.82
Lander	2,379.23	49.11	200.91	937.97			3,567.22
Lincoln		697.15	9.54	605.28		18.00	1,329.97
Lyon	32.07	3,805.71	1.60				3,839.38
Mineral	45.33	9,113.37	6.40	85.12			9,250.22
Nye	3,804.40	70,554.37	3.01	38.00			74,399.78
Ormsby		8.47					8.47
Pershing	45.72	7,121.30	16.91	5.66			7,189.59
Storey		17,204.09					17,204.09
Washoe		260.61	3.62				264.23
White Pine	19.79	29.39	15,580.66	125.15	15.02		15,770.01
	6,399.43	[a]194,008.03	16,254.92	2,481.11	511.52	40.15	219,695.16

[a] Includes 111,170.33 ounces from gold ore, 28,478.76 ounces from gold and silver ore, and 54,358.94 ounces from silver ore.

SILVER.

The mine production of silver in Nevada in 1919 decreased 3,137,019 ounces in quantity and $2,313,389 in value, as compared with the output of 1918. Nye County again made the largest output—3,622,680 ounces, against 6,104,711 ounces in 1918; Pershing County produced 706,734 ounces; and Churchill County produced 488,053 ounces, against 625,152 ounces in 1918. Milling plants produced 5,600,563 ounces of silver, 16,555 ounces by amalgamation and 5,584,008 ounces by cyanidation. Nye County was credited with 3,519,347 ounces, the largest output of silver by cyanidation, from ores treated principally in the Tonopah district. In the Rochester district, Pershing County, 624,463 ounces of silver was recovered by cyanidation. Concentrates from milling plants yielded 281,454 ounces of silver, against 509,928 ounces in 1918. Siliceous concentrates contained 91,877 ounces, against 191,632 ounces in 1918; and copper concentrates 55,646 ounces, against 116,834 ounces in 1918. Lead concentrates contained 131,949 ounces of silver, or an average per ton of 47.07 ounces, against 180,372 ounces, or an average of 32.71 ounces, in 1918.

More than 55 per cent of the total silver was produced in 1919 from the Tonopah Extension, Belmont, Tonopah Mining, and West End mines, all at Tonopah; the Nevada Wonder, in Churchill County; and the Rochester Nevada, in Pershing County.

Mine production of silver in Nevada in 1919, in fine ounces.

County.	Placers.	Deep mines.					Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	
Churchill	.....	487,824	.....	229	.....	.....	488,053
Clark	.....	117,815	568	36,924	1,712	101,269	258,288
Elko	.....	156,494	587	44,255	.....	.....	201,336
Esmeralda	.....	288,688	1,459	2,781	.....	.....	292,928
Eureka	2	16,130	.....	53,391	.....	.....	69,523
Humboldt	8	7,876	.....	2,258	.....	.....	10,142
Lander	319	28,910	4,667	39,887	.....	.....	73,783
Lincoln	.....	332,042	5,359	116,631	.....	3,120	457,152
Lyon	4	61,856	1,000	.....	.....	.....	62,860
Mineral	28	69,804	2,444	11,964	.....	.....	84,240
Nye	1,999	3,605,981	178	14,522	.....	.....	3,622,680
Ormsby	.....	1,880	.....	.....	.....	.....	1,880
Pershing	9	700,594	2,564	3,567	.....	.....	706,734
Storey	.....	395,784	.....	.....	.....	.....	395,784
Washoe	.....	1,862	2,288	.....	.....	.....	4,150
White Pine	5	33,043	52,257	47,109	1,633	.....	134,047
	2,374	[a] 6,306,583	73,371	373,518	3,345	104,389	6,863,580

[a] Includes 102,926 ounces from gold ore, 556,645 ounces from gold and silver ore, and 5,647,012 ounces from silver ore.

COPPER.

The mine production of copper in Nevada in 1919 decreased 63,985,266 pounds in quantity and $18,996,562 in value. The Nevada Consolidated mines and the Consolidated Coppermines Co., at Ely, in White Pine County, were the largest producers of copper, followed by the mines in the Yerington district, Lyon County. White Pine County mines produced 47,912,943 pounds in 1919, against 92,538,218 pounds in 1918; Lyon County 3,076,647 pounds, against 17,138,747 pounds in 1918; Mineral County 296,815 pounds, against 2,228,337 pounds; Lander County 277,699 pounds, against 2,261,246 pounds; and Esmeralda County 128,278 pounds, against 551,987 pounds. Concentrates recovered at milling plants contained 45,532,201 pounds of copper, against 85,860,578 pounds in 1918. Of the output in 1919, copper concentrates contained 45,517,137 pounds, against 85,854,958 pounds in 1918. Crude ore shipped to smelters contained 6,718,091 pounds of copper, against 30,356,382 pounds in 1918. The crude copper ores smelted contained 6,535,129 pounds, of which 1,371,732 pounds was produced from sulphide ores and 5,163,397 pounds from oxidized ores. Lead ores of smelting grade produced 71,495 pounds of copper—3,165 pounds from sulphide ores and 68,330 pounds from oxidized ores. Copper-lead ores shipped, all of which were oxidized, contained 11,207 pounds of copper.

Eight mines produced more than 98 per cent of the copper in 1919. The Nevada Consolidated and the Consolidated Coppermines, near Ely, had the greatest output, followed by the Blue Stone, Nevada Douglas, and Mason Valley mines, in the Yerington district, Lyon County; the Copper Canyon mine, in Lander County; the Majuba Hills property, in Pershing County; and the Northern Light property, in Mineral County.

Mine production of copper in Nevada in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Clark	41	130,601	3,745	14,082	.....	148,469
Elko	60	109,578	12,882	.....	.....	122,520
Esmeralda	116,117	11,875	286	.....	.....	128,278
Eureka	34,118	.....	6,595	.....	.....	40,713
Humboldt	.....	7,218	5	.....	.....	7,223
Lander	601	271,810	5,288	.....	.....	277,699
Lincoln	37,496	68,308	9,145	.....	590	115,539
Lyon	.....	3,076,647	.....	.....	.....	3,076,647
Mineral	214	296,398	203	.....	.....	296,815
Nye	40	14,818	512	.....	.....	15,370
Pershing	1,017	185,008	.....	.....	.....	186,025
Storey	223	.....	.....	.....	.....	223
Washoe	.....	2,711	.....	.....	.....	2,711
White Pine	1,836	47,867,117	33,201	10,789	.....	47,912,943
	[a] 191,763	52,042,089	71,862	24,871	590	52,331,175

[a] Includes 149,168 pounds from gold ore and 42,595 pounds from silver ore.

LEAD.

The mine production of lead in Nevada in 1919 decreased 7,967,164 pounds in quantity and $841,957 in value. Lincoln County continued to have the largest output, followed by Clark County and White Pine County. More than 22 per cent of the lead was derived from the concentrates of milling ores, and nearly 77 per cent from crude ore shipped directly to smelters. Lead concentrates (carbonates and sulphides) shipped to smelters contained 2,891,009 pounds of lead, against 4,072,281 pounds in 1918, and averaged 51.57 per cent of lead, against 36.92 per cent in 1918. Zinc concentrates shipped in 1919 contained 566,510 pounds of lead and averaged 3.45 per cent. The total crude ore of shipping grade contained 11,804,210 pounds of lead, against 18,628,912 pounds in 1918. The iron-manganese ores, classified under dry or siliceous ores, contained 5,880,677 pounds of lead. Oxidized lead ore shipped to smelters contained 4,899,614 pounds of lead, and sulphide ore 782,121 pounds, against 7,545,496 pounds and 3,108,327 pounds, respectively, in 1918. Zinc ores shipped produced 10,190 pounds of lead, all from oxidized ores. Copper-lead ore of shipping grade, all of which was oxidized, produced 55,930 pounds of lead. The oxidized lead-zinc ores of smelting grade produced 126,994 pounds of lead.

More than 73 per cent of the lead came from six mines. The leading producer was the Prince Consolidated mine, near Pioche, Lincoln County, followed by the Yellow Pine mine, Clark County; the Virginia Louise, Lincoln County; the Eureka Holly, Eureka County; the Nevada United, White Pine County; and the Nevada Volcano, Lincoln County.

Mine production of lead in Nevada in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Churchill	2,152	.....	20,780	.....	.....	.....	22,932
Clark	68	.....	1,148,213	10,190	39,307	3,059,336	4,257,114
Elko	71	.....	848,950	.....	.....	.....	849,021
Esmeralda	14,230	.....	65,064	.....	.....	.....	79,294
Eureka	63,669	.....	1,116,054	.....	.....	.....	1,179,723
Humboldt	504	.....	34,951	.....	.....	.....	35,455
Lander	172	.....	387,198	.....	.....	.....	387,370
Lincoln	5,883,144	6,471	1,089,603	.....	.....	72,170	7,051,388
Mineral	1,446	.....	63,758	.....	.....	.....	65,204
Nye	603	.....	54,669	.....	.....	.....	55,272
Pershing	346	.....	21,232	.....	.....	.....	21,578
Storey	2,958	.....	.....	.....	.....	.....	2,958
White Pine	17,764	.....	1,271,191	.....	53,106	.....	1,342,061
	[a] 5,987,127	6,471	6,121,663	10,190	92,413	3,131,506	15,349,370

[a] Includes 56,191 pounds from gold ore and 5,930,936 pounds from silver ore.

ZINC.

The mine production of recoverable zinc from zinc and lead zinc ores in Nevada in 1919 is calculated as 9,004,698 pounds, valued at $657,343, against 16,724,753 pounds, valued at $1,521,953, in 1918. Clark County made the largest part of the output, all of it from the Yellow Pine district, and was followed in order by Ely, in White Pine County, and the Pioche district, in Lincoln County. The quantities of ore and concentrates sold are shown in the second of the accompanying tables. The oxidized lead-zinc ore from the Yellow Pine district, Clark County, was of particular value to the oxide plants in the Eastern States.

More than 95 per cent of the zinc was obtained from ores produced at four mines—the Yellow Pine, Potosi, and Goodsprings Mining Co., all in Clark County; and the Consolidated Coppermines Co., at Ely, in White Pine County.

Mine production of recoverable zinc in Nevada in 1919, in pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Clark	677,915	5,296,304	5,974,219
Lincoln	.....	78,200	78,200
White Pine	2,952,279	.....	2,952,279
	3,630,194	5,374,504	9,004,698

Zinc-producing ores and concentrates from Nevada mines sold in 1919.

Classification.	County.	Quantity.	Average zinc assay of ore and concentrate. [a]	Recoverable zinc.
		Short tons.	*Per cent.*	*Per cent.*
Oxidized zinc ore	Clark and White Pine	4,867	43.88	37.29
Oxidized lead-zinc ore	Clark	662	30.51	25.94
Zinc concentrates	Clark and Lincoln	8,208	36.06	30.65
		13,737	38.56	.....

[a] Actual assay content.

MINING INDUSTRY IN NEVADA.

Nevada mine operators generally were benefited by the high price of silver in 1919, which, because of the Pittman Act, will probably be continued for several years. The high price, however, did not lead to the opening of any valuable new silver deposits nor did it avert the labor strikes, which extended to several mining districts. Labor trouble at Ely, Tonopah, Divide, Virginia City, and Copper Canyon seriously interfered with operations and was the cause of the decrease in the output of silver. The mine laborers of the Nevada Consolidated mines at Ely returned to work August 30 after agreeing to forfeit all claim to wage increases in view of a guaranty by the company for improved working conditions and the establishment of a commissary. The labor strike at Tonopah and Divide, which began August 17, was settled October 2 by the governor of Nevada, although the miners and mill men did not return in great number and at the end of the year the conditions were far from normal. The Tonopah and Divide miners accepted a proposal of the operators providing for an immediate increase of wages of 50 cents a day and a commissary to handle meats, groceries, wood, coal, and miners' clothing. This agreement is to remain in force until a Federal mediator decides that the commissary has resulted in a reduction in the cost of living amounting to 50 cents a day.

Ores of various kinds were milled at 63 plants in 1919, against 76 plants in 1918. Many of these plants were operated for only short periods in each year. Sixteen plants used the amalgamation process, against 26 in 1918; 4 both amalgamation and table concentration, against 2 in 1918; 1 amalgamation and cyanidation, against 5 in 1918. Twelve plants, against 14 in 1918, used concentration, of which 5 were equipped with the oil-flotation process in conjunction with the tables and 1 was equipped for dry concentration. Twenty-five straight cyanidation mills were operated in 1919, against 24 in 1918; and 4 mills used cyanidation and concentration, against 3 in 1918.

About 1,300 pounds of quicksilver was purchased for amalgamation mills and placer operations. At cyanide mills 992,840 pounds of sodium cyanide and 50,271 pounds of potassium cyanide were used. This represents 0.029 pound of mercury per ounce of gold and silver bullion produced and 0.02 pound of mercury per ton of ore treated; the consumption of cyanide was 0.182 pound per ounce of gold and silver bullion produced and 1.70 pounds per ton of ore and tailings treated. The total value of bullion recovered from ore and tailings was $9,728,550, against $13,007,287 in 1918.

Gold and silver produced from Nevada mills in 1919.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Churchill	40,680	3.00	.....	5,635.00	465,190	$637,561
Clark	[a] 14,786	719.86	1,043	[b] 5,227.76	[b] 110,990	248,425
Elko	[c] 57,960	264.83	161	[d] 33,749.60	[d] 155,176	877,118
Esmeralda	[e] 20,294	.....	.....	16,185.70	258,195	623,766
Humboldt	2	7.72	7	.....	.....	168
Lincoln	25	.....	.....	5.95	14	139
Lyon	8,739	978.70	944	[f] 2,827.04	[f] 57,967	144,652
Mineral	13,432	145.25	39	7,858.94	7,237	173,610
Nye	[g] 334,426	23,355.72	12,329	[h] 46,672.55	[h] 3,519,347	5,403,090
Pershing	[i] 109,989	961.59	795	[j] 5,423.24	[j] 624,463	832,275
Storey	[k] 38,289	421.89	1,131	[l] 16,478.03	[l] 385,429	782,299
Washoe	162	257.77	106	.....	.....	5,447
	638,784	27,116.33	16,555	140,063.81	5,584,008	9,728,550

[a] Also yielded 16 tons of concentrates.
[b] Includes bullion from 2,125 tons of old tailings.
[c] Also yielded 2 tons of concentrates.
[d] Includes bullion from 60 tons of old tailings.
[e] Also yielded 859 tons of concentrates.
[f] Includes bullion from 15,270 tons of old tailings.
[g] Also yielded 378 tons of concentrates.
[h] Includes bullion from 5,732 tons of old tailings.
[i] Also yielded 56 tons of concentrates.
[j] Includes bullion from 220 tons of old tailings.
[k] Also yielded 42 tons of concentrates.
[l] Includes bullion from 12,037 tons of old tailings.

Mills equipped for the concentration of low-grade ore treated more than 72 per cent of the total ore sold or treated. The average value of the concentrates per ton was $34.27.

Mine production of gold, silver, copper, lead, and zinc from Nevada concentrates in 1919.

By counties.

County.	Ore to concentrating mills.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Clark	19,770	10,671	528.35	111,498	11,192	3,297,966	4,952,916	$674,237
Elko	.....	2	27.40	51	.....	.....	.....	623
Esmeralda	156	898	1,939.86	18,640	56,204	49,881	.....	74,075
Lander	1,779	102	78.69	8,420	367	47,911	.....	13,664
Lincoln	498	249	18.00	3,120	590	72,170	78,200	13,510
Lyon	42,758	2,902	.....	1,000	1,188,556	.....	.....	222,191
Nye	.....	378	408.72	60,156	.....	.....	.....	75,824
Pershing	2,394	300	259.42	26,522	.....	480	.....	35,093
Storey	.....	58	115.00	1,318	223	2,958	.....	4,051
White Pine	2,233,108	267,951	14,981.59	50,729	44,275,069	23,396	.....	8,602,916
	2,300,463	283,511	18,357.03	281,454	45,532,201	3,494,762	5,031,116	9,716,184

By kinds of concentrates.

Dry or siliceous	.....	746	993.49	91,877	.....	760	.....	$123,479
Copper	.....	271,653	16,830.08	55,646	45,517,137	.....	.....	8,876,419
Lead	.....	2,803	161.64	131,949	1,400	2,891,009	.....	304,607
Zinc	.....	8,208	.....	.....	.....	566,510	5,031,116	397,297
Copper-lead	.....	101	371.82	1,982	13,664	36,483	.....	14,382

All the higher-grade ores were shipped crude to the smelters, the siliceous ores in greatest quantity and value. There were 210,612 tons of ore smelted in 1919, as compared with 623,828 tons in 1918. The smelters in Utah and California receive most of the lead and silver ores produced in Nevada. Shipments from several mines were curtailed by the closing of the Mammoth smelter at Kennett, Shasta County, Calif., May 15, 1919, after an attempt to operate in spite of excessive costs. It is reported [2] that the smelter workers refused to continue on a reduced wage scale. The output of smelting ores, by counties, follows:

Mine production of gold, silver, copper, lead, and zinc from Nevada crude ore shipped to smelters in 1919.

By counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Churchill	212	178.15	22,863	.....	22,932	.....	$30,505
Clark	3,474	540.48	34,757	137,277	959,148	1,021,303	201,024
Elko	1,991	24.54	45,948	122,520	849,021	.....	119,756
Esmeralda	8,033	19,973.57	16,093	72,074	29,413	.....	445,879
Eureka	2,360	834.82	67,368	6,595	1,129,325	.....	153,790
Humboldt	216	726.77	10,127	7,223	35,455	.....	29,589
Lander	3,084	1,109.26	65,044	277,332	339,459	.....	165,355
Lincoln	96,152	1,306.02	454,018	114,949	6,979,218	.....	926,777
Lyon	41,949	1.60	2,945	1,842,284	.....	.....	345,996
Mineral	5,497	1,200.67	76,936	296,815	65,204	.....	169,652
Nye	610	158.44	28,849	15,370	55,272	.....	41,374
Ormsby	104	8.45	1,880	.....	.....	.....	2,281
Pershing	2,485	418.24	40,664	185,067	21,098	.....	89,730
Storey	50	189.18	7,906	.....	.....	.....	12,766
Washoe	75	6.46	4,044	2,711	.....	.....	5,167
White Pine	44,320	768.65	83,313	3,637,874	1,318,665	2,952,279	1,071,249
	210,612	27,445.30	962,755	6,718,091	11,804,210	3,973,582	3,810,890

By kinds of ore.

Dry or siliceous	105,607	23,630.30	580,099	100,260	5,922,890	.....	$1,470,754
Copper	86,259	1,273.83	22,473	6,535,129	6,471	.....	1,267,379
Lead	13,063	2,401.47	358,820	71,495	5,681,735	.....	765,951
Zinc	4,867	.....	.....	.....	10,190	3,630,194	265,544
Copper-lead	154	139.70	1,363	11,207	55,930	.....	9,464
Lead-zinc	662	.....	.....	.....	126,994	343,388	31,798

[2] Eng. and Min. Jour., p. 979, May 31, 1919.

PRODUCTION BY COUNTIES.

The subjoined tables are followed by a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Nevada in 1919.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Churchill			5,816.13	$120,230	$120,230	488,053	$546,619
Clark			7,016.45	145,043	145,043	258,288	289,283
Elko	1.98	$41	34,066.40	704,215	704,256	201,336	225,496
Esmeralda			38,099.13	787,579	787,579	292,928	328,079
Eureka	27.57	570	1,066.72	22,051	22,621	69,523	77,866
Humboldt	43.34	896	734.48	15,183	16,079	10,142	11,359
Lander	2,379.23	49,183	1,187.99	24,558	73,741	73,783	82,637
Lincoln			1,329.97	27,493	27,493	457,152	512,010
Lyon	32.07	663	3,807.31	78,704	79,367	62,860	70,403
Mineral	45.33	937	9,204.89	190,282	191,219	84,240	94,349
Nye	3,804.40	78,644	70,595.38	1,459,336	1,537,980	3,622,680	4,057,402
Ormsby			8.47	175	175	1,880	2,106
Pershing	45.72	945	7,143.87	147,677	148,622	706,734	791,542
Storey			17,204.09	355,640	355,640	395,784	443,278
Washoe			264.23	5,462	5,462	4,150	4,648
White Pine	19.79	409	15,750.22	325,586	325,995	134,047	150,133
	6,399.43	132,288	213,295.73	4,409,214	4,541,502	6,863,580	7,687,210

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Churchill			22,932	$1,215			$668,064
Clark	148,469	$27,615	4,257,114	225,627	5,974,219	$436,118	1,123,686
Elko	122,520	22,789	849,021	44,998			997,539
Esmeralda	128,278	23,860	79,294	4,203			1,143,721
Eureka	40,713	7,573	1,179,723	62,525			170,585
Humboldt	7,223	1,344	35,455	1,879			30,661
Lander	277,699	51,652	387,370	20,531			228,561
Lincoln	115,539	21,490	7,051,388	373,724	78,200	5,709	940,426
Lyon	3,076,647	572,256					722,026
Mineral	296,815	55,208	65,204	3,456			344,232
Nye	15,370	2,859	55,272	2,929			5,601,170
Ormsby							2,281
Pershing	186,025	34,601	21,578	1,144			975,909
Storey	223	41	2,958	157			799,116
Washoe	2,711	504					10,614
White Pine	47,912,943	8,911,807	1,342,061	71,129	2,952,279	215,516	9,674,580
	52,331,175	9,733,599	15,349,370	813,517	9,004,698	657,343	23,433,171

Production from deep mines in Nevada in 1918 and 1919.

County.	Ore sold or treated.		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	1919	Increase or decrease.	1918	1919	1918	1919	1918	1919
	Short tons.	*Short tons.*						
Churchill	40,892	— 9,058	13	12	$14.63	$16.34	$14.57	$16.31
Clark	40,155	— 17,479	61	40	41.88	27.98	7.39	10.82
Douglas	.....	— 57	3	.....	26.17	.....	13.14	.....
Elko	60,011	+ 9,213	39	27	20.06	16.62	17.39	15.66
Esmeralda	28,483	— 265,271	55	20	6.23	40.15	5.73	39.17
Eureka	3,428	— 1,508	32	18	41.08	49.60	20.47	29.15
Humboldt[b]	218	— 119,125	92	13	10.06	136.49	9.39	121.71
Lander	4,863	— 20,569	48	25	32.19	36.81	9.59	21.97
Lincoln	96,675	— 18,326	12	17	10.76	9.73	3.86	5.58
Lyon	109,898	— 304,389	44	23	10.52	6.56	.30	1.36
Mineral	18,929	— 138,206	81	37	9.50	18.13	5.92	15.04
Nye	340,768	— 211,313	79	50	14.47	16.20	14.41	16.18
Ormsby	104	— 263	3	2	10.93	21.93	10.68	21.93
Pershing[b]	115,366	+ 115,366	.....	40	.....	8.45	.....	8.14
Storey	50,376	— 44,675	29	21	8.83	15.86	8.83	15.86
Washoe	237	— 1,854	21	11	23.27	44.78	17.75	42.66
White Pine	2,277,428	—2,257,234	48	28	5.32	4.25	.19	.21
	3,187,831	—3,284,748	660	384	7.46	7.31	2.53	3.79

[a] Value per ton, placer product excluded.

[b] Humboldt County divided in 1918 and new county of Pershing created.

Production from placer mines in Nevada in 1918 and 1919.

County.	1918					1919				
	Mines.		Gold.	Silver.	Total value.	Mines.		Gold.	Silver.	Total value.
	Hydraulic.	Drift.				Hydraulic.	Drift.			
				Fine ounces.					*Fine ounces.*	
Douglas	1	.....	$94	1	$95	.....	.....	.....	.....	.....
Elko	5	.....	345	6	351	1	.....	$41	.....	$41
Eureka	4	.....	1,660	7	1,667	2	.....	570	2	572
Humboldt	4	.....	929	16	945	1	.....	896	8	905
Lander	4	2	76,279	490	76,769	7	1	49,183	319	49,540
Lyon	.....	.....	.....	.....	.....	1	.....	663	4	668
Mineral	4	.....	983	48	1,031	5	.....	937	28	968
Nye	25	5	138,090	3,339	141,429	9	7	78,644	1,999	80,883
Pershing	.....	.....	.....	.....	.....	2	.....	945	9	955
White Pine	.....	.....	.....	.....	.....	1	.....	409	5	415
	47	7	218,380	3,907	222,287	29	8	132,288	2,374	134,947

CHURCHILL COUNTY.

Of the total output of Churchill County the larger part—40,680 tons—was ore of milling grade, which yielded gold and silver bullion by cyanidation. The ore shipped, 212 tons, contained gold and silver and some lead.

Eagleville district.—Gold ore of shipping grade, containing a little silver, was produced from the Golden Extension property.

Fairview district.—From the Nevada Hills property lessees cleaned up a small quantity of silver ore containing gold. A small output of lead ore containing silver was also shipped to the smelter from the Chalk Mountain property.

Holy Cross district (Fallon).—A small quantity of silver ore was shipped from the Silver Star claim in 1919.

La Plata district.—Prospectors shipped from the Argenta property in the Silver Range, a little silver ore.

Wonder district.—In November, 1919, the mill of the Nevada Wonder property was closed. It is said that the mine has been entirely exhausted of ore. About 40,000 tons of ore from this property was treated by cyanidation and yielded silver and gold bullion. Other producers in the district were the Atlas and Queen properties, from which small quantities of silver ore were mined.

From the Nevada Wonder mine[3] 40,570 tons of ore was mined in 1919 and treated by cyanidation, which yielded 93.99 per cent of the combined gold and silver, 2.17 per cent more than in 1918, as all ore came from the upper parts of the mine, where very little sulphide ore was found. The mining and milling of ore was continued until about the end of November, when, no further ore being available, the mine was closed. On December 4, after the contents of the mill solution had been extracted, milling operations ceased.

The company report contains the following information:

The following table furnishes the ratio of gold and silver values and average gross value per ton during the past four years:

Contents and value per ton.

Year.	Gold.	Silver.	Value.	Average value, silver.
	Ounces.	*Ounces.*	*Per ton.*	*Per ounce.*
1916	0.159	18.72	$15.40	$0.647
1917	.141	16.65	16.65	.817
1918	.103	13.23	14.93	.966
1919	.136	11.56	15.51	1.099

The cost of producing an ounce of silver in 1919 was $0.491, which is arrived at by considering the gold as a by-product and subtracting its value from the operating costs, and dividing the remainder by the total ounces of silver produced.

The following gives a comparison of the mining costs for the past four years, and also comparison of costs of development during the same period:

	1916	1917	1918	1919
Direct cost	$4.46	$5.41	$4.48	$2.65
Indirect cost	.83	.97	1.04	1.07
	5.29	6.38	5.52	3.72
Development work (average cost per foot)	9.31	11.05	11.65	9.43

This table shows a decrease in mining costs of $1.80 per ton, and this is again caused by treating some 12,500 tons of reserve ore already broken in the stopes, together with 5,456 tons of ore from a second-class dump.

[3] Nevada Wonder Mining Co. Thirteenth Ann. Rept., for year ending Dec. 31, 1919.

The combined mining and milling costs and profit per ton of ore are given below, and comparison made with costs of past four years:

Mining and milling costs and profits per ton of ore mined and milled, Nevada Wonder mine, 1916–1919.

	1916	1917	1918	1919
Total mining cost per ton of ore, including transportation	$5.33	$6.43	$5.58	$3.78
Total milling cost per ton of ore	3.31	4.12	4.26	4.20
Marketing cost per ton of ore	.26	.23	.25	.19
Total cost per ton	8.90	10.78	10.09	8.17
Average value per ton of ore	15.40	16.55	14.93	15.50
Loss in tailings per ton of ore	1.13	1.80	1.22	.93
Recovery per ton of ore	14.27	14.75	13.71	14.57
Less total cost per ton of ore	8.90	10.78	10.09	8.17
Profit per ton of ore mined and milled	5.37	3.97	3.62	6.40

This shows a profit of $6.40 per ton of ore for the year 1919.

Broken Hills district.—Some rich silver ore was shipped from the Broken Hills & Cracker Jack property by the owners, Arthur & Stratford.

CLARK COUNTY.

Mine production in Clark County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	61	57,634	$173,477	252,694	467,486	6,541,129	15,472,155	$2,414,026
1919	40	40,155	145,043	258,288	148,469	4,257,114	5,974,219	1,123,686
Increase or decrease, 1919	−21	−17,479	−28,434	+5,594	−319,017	−2,284,015	−9,497,936	−1,290,340

Although the average value per ton decreased, the gold and silver value per ton in the ore increased from $7.39 to $10.82. Of the total ore, 3,474 tons was shipped directly to the smelters and produced metals valued at $201,024, or an average of $57.87 a ton. Ore treated by concentration or separation amounted to 19,770 tons and produced lead concentrates and zinc concentrates. The 10,671 tons of concentrates produced had a metal content of $10,922 in gold, 111,498 ounces of silver, 11,192 pounds of copper, 3,297,966 pounds of lead, and 4,952,916 pounds of recoverable zinc, valued in all at $674,237, or an average of $63.18 a ton. At gold and silver mills, 14,786 tons of ore was treated and produced $122,948 in gold and 112,033 ounces of silver.

Eldorado Canyon district.—Four producers of ore reported the output of 13,875 tons, containing $73,460 in gold, 113,039 ounces of silver, valued in all at $200,064. All this ore, except 46 tons shipped to the smelter, was of milling grade, yielding gold and silver bullion, principally by cyanidation. The Techatticup mine made the largest

yield of silver bullion containing gold, followed by the Rand and Carnation properties.

Searchlight district.—From the operations of nine producers, 6,980 tons of ore was mined, containing $59,005 in gold, 5,502 ounces of silver, 18,074 pounds of copper, and 39,307 pounds of lead, valued in all at $70,612. All but 73 tons of ore, which was of smelting grade, was milled and produced gold and silver by amalgamation and some gold concentrate containing copper and lead. The Cyrus Noble, Kansas City, Quartette, and Peerless groups were the principal producers.

Sunset district (Desert, Calif.).—In 1919 the Lucy Gray property was credited with a small output of gold bullion, which was said to have been the result of former operations.

Yellow Pine district.—Twenty-six producers reported 19,273 tons of ore, containing $11,650 in gold, 139,656 ounces of silver, 130,395 pounds of copper, 4,217,739 pounds of lead, and 5,974,219 pounds of zinc, valued in all at $851,976. There were 3,353 tons of ore shipped directly to the smelters, containing 370.62 ounces of gold, 33,713 ounces of silver, 130,395 pounds of copper, 950,260 pounds of lead, and 1,021,303 pounds of zinc. There were also 14,970 tons of ore concentrated, producing concentrate containing lead, zinc, and some silver. Some old tailing was re-treated by cyanidation, producing gold and silver bullion. The Yellow Pine mine was the largest producer of crude ore and concentrates, which were shipped to various smelters. Next in rank were the Anchor and Potosi properties, from which lead ore and concentrate were shipped. The Boss mine produced some palladium and platinum ores containing silver and gold, shipped for reduction to the smelters in Utah and to Irvington, N. J. Smaller quantities of both lead ore and zinc ore were shipped from the Bill Nye, Dawn, Milford & Addison, High Line, Sultan, Yellow Pine Extension, Green Monster, Ingomar, and Annex, and some copper ore was shipped from the Coppersides property. The Keystone mill on a property of that name was operated on old tailings, and gold bullion was recovered by cyanidation.

From the Yellow Pine mine [4] 11,279 tons of crude ore and concentrates was shipped, which netted $319,140, or an average of $28.29 a ton. Of the total product shipped, 2,217 tons was lead concentrate, averaging in value $73.82 a ton; 6,704 tons of zinc concentrate, averaging $13.60 a ton; 865 tons crude lead ore, averaging $50.13 a ton; 102 tons crude zinc ore, averaging $22.70 a ton; and 1,390 tons slimes, averaging $12.55 a ton. The operating expense for mining was $6.20 a ton; milling $2.72 a ton; railroad $2.40 a ton, which with miscellaneous expenses made a total operating expense of $14.04 a ton and left an operating profit of $14.25 a ton. From the company's annual report the following extracts are taken:

> Beginning January 1 the mill and mine continued in full operation up to March 6, on which date a fire completely destroyed the hoisting plant at the mine, necessitating the closing of both the mine and the mill. On account of the low price of metals it was decided to remodel the mill and install a calcining plant for the drying and roasting of the zinc concentrates, while the hoisting plant was being installed at the mine. * * *
>
> The mill was completely remodeled and eight Deister-Overstrom tables, screens, jigs, and storage bins were installed. The new calcining plant consists of 5 by 50 Vulcan

[4] Yellow Pine Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

Iron Works oil-fired rotary calciner fed by a Jeffry pan conveyor. The calciner discharges into a screw conveyor, which carries the product direct to an elevator, and thence to storage bins for loading into railroad cars.

The calcining operation eliminates approximately 30 per cent by weight of the zinc concentrates, and makes a material saving in freight and smelter charges. * * *

Mining operations, which were stopped in March, were resumed in June and continued throughout the balance of the year, the greater portion of the ore produced coming from the 700 level stope.

DOUGLAS COUNTY.

Very little development of mining property took place in 1919, except the work done on the Longfellow property, in Red Canyon, and the Ruby Hill, near Gardnerville. The miner and prospector were not compelled to do assessment work, which, in other years, was necessary to hold unpatented claims. In the Mount Siegel district more or less placering is done on a small scale, but the output is not reported to the Survey. Not more than 10 ounces of placer gold was produced in 1919.

ELKO COUNTY.

Mine production in Elko County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	44	50,798	$653,748	a230,084	343,941	687,989	17,995	$1,019,270
1919	28	60,011	704,256	201,336	122,520	849,021	.....	997,539
Increase or decrease, 1919	−16	+9,213	+50,508	−28,748	−221,421	+161,032	−17,995	−21,731

[a] Includes placer production.

A large part of the ore mined in Elko County (57,960 tons) was treated at gold and silver mills and yielded bullion containing $703,141 in gold and 155,337 ounces of silver. The ore shipped was 1,991 tons, containing gold, silver, copper, and lead, valued at $119,756, or an average of $60.15 a ton. A small quantity of placer gold was reported from one property.

Aura district.—Silver ore produced from the Big Four property was reported as shipped.

Contact or Salmon River district.—The Bellevue property produced some copper ore containing silver and a little gold, mined in the development of the property.

Delno district.—Oxidized lead ore containing silver was shipped from the Net No. 2 and Gold Bond properties.

Gold Circle district (Midas).—Six producers reported the output of 15,586 tons of ore, from which was recovered gold and silver bullion containing $195,604 in gold and 132,079 ounces of silver, valued in all at $343,532. The larger part of the ore mined was from the Elko Prince property, which is equipped with a cyanidation plant. A general statement issued by the company[5] operating

[5] Elko Prince Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

the Elko Prince mine shows the ore reserves of the property to be about 20,909 tons of an average value of $19.15 a ton. Based on silver at $1 an ounce, this ore has a gross value of $400,609, or a net value of approximately $140,000. The report of the company continues as follows:

> Operations were interrupted in April and June, 1919, owing to generator trouble, and resulting in approximately six weeks' loss of time with consequent higher costs per ton of ore mined and milled. There were 16,646 tons of ore mined and 15,214 tons, averaging $22.89 per ton, milled. The average extraction was 90.04 per cent, or $20.59 per ton. The average price received for silver was $1.129.
>
> Mining costs in 1919 were $4.72 per ton milled, as against $2.933 in 1918 and $3.26 in 1917. Milling costs in 1919 were $4.555, as against $3.631 in 1918 and $3.011 in 1917; operating time, 79.47 per cent, as against 93.3 per cent in 1918 and 88.3 per cent in 1917. Total cost per ton milled in 1919, including development, was $12.13.
>
> The most important development work during the year consisted of opening up the North ore shoot. The 600 North drift was driven 860 feet, and connections made with the 300 North drift. Results obtained were very gratifying. The 750 North drift is now being extended, as it is believed that this shoot extends at least to that level.
>
> Development to the south consisted of approximately 600 feet of drifts and raises to determine the extent of the low-grade ores remaining in this ore body. During the year a total of 2,176 linear feet of development work was done.

Some of the ore produced from other properties in the district, chiefly the Rex, Big Chief, and Regalia claims, was treated at the Elko Prince mill. At the Esperanza mill, which has two stamps and amalgamation plates, some ore mined in 1917 and a test lot from the Queen property were treated.

Island Mountain district (*Gold Creek*).—Development work carried on by the Hammond Exploration Co. resulted in a small output of bullion from previous operations.

Jarbidge district.—Development work continued at several properties in the district, but the most extensive was that of the Elkoro Mines Co., operating the Starlight, Long Hike, and O. K. properties. Gold and silver precipitates were produced from its cyanidation plant, which, during operations in 1919, averaged 112 tons of ore a day. The ore is ground in Marcy and Hardinge mills, and the Dorr countercurrent decantation process with Oliver continuous filter completes the treatment, the tailings going to the waste dump. Shipments of product are made by the way of Rogerson, Idaho, a station on the Oregon Short Line Railroad. The Legitimate mine produced ore containing gold and silver, which was treated by amalgamation in a 5-stamp mill. A small quantity of bullion was recovered from ore from the Arizona property.

Lee district.—The B. & B. property yielded a little copper ore of shipping grade in 1919.

Loray district.—A small shipment of silver ore was made from the Alabama claim.

Lone Mountain district.—From the Rip Van Winkle mine some lead ore, containing silver and a little copper and gold, was shipped to the smelter.

Railroad district.—Four producers reported the output of 254 tons of ore, containing $196 in gold, 4,380 ounces of silver, 30,288 pounds of copper, and 79,096 pounds of lead, valued in all at $14,927. The larger part of the output was from the Bunker Hill property, and the Mayflower and Sweepstake claims also produced some ore. The Bunker Hill Co. shipped to the smelter oxidized copper and lead ores from Raines siding, on the Eureka Northern Railroad.

Spruce Mountain district.—In 1919 the Black Forest Mining Co. sold some oxidized lead ore of shipping grade containing silver. The property is equipped with a small water-jacket lead smelter, which has been idle since 1909. Shipments consisting of lead ore containing silver were also made from the Spruce Monarch mine. The ore is loaded at Tobar, on the Western Pacific Railroad, 22 miles north of the district. A 50-ton smelter was completed for the Bullshead Mining Co., and the initial run was made the last week of November on lead ore from the Black Forest property.

Tuscarora district.—Development work in the district was done on a small scale, resulting in the production of some silver bullion containing gold.

ESMERALDA COUNTY.

Mine production in Esmeralda County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	55	293,754	$1,361,321	322,690	551,987	158,583	$1,831,611
1919	20	28,483	787,579	292,928	128,278	79,294	1,143,721
Decrease, 1919	35	265,271	573,742	29,762	423,709	79,289	687,890

Of the total ore, 20,294 tons treated by cyanidation yielded $334,588 in gold and 258,195 ounces of silver, or an average value of $30.74 a ton. There was 156 tons of ore treated at concentration mills, which, with ore treated by concentration and cyanidation, produced 898 tons of concentrates, containing gold, silver, copper, and lead. These concentrates, with 8,033 tons of crude ore, were shipped to the smelters. The crude ore contained $412,890 in gold, 16,093 ounces of silver, 72,074 pounds of copper, and 29,413 pounds of lead, valued in all at $445,879, or an average of $55.51 a ton. No placer production was reported in 1919.

Columbus district.—In opening the Native Silver group of claims, 4 miles southeast of Candelaria, a small quantity of copper ore was shipped to the smelter in 1919. This is an old property said to have been worked before 1873.

Goldfield district.—With the exception of lead, all metals produced in the Goldfield district in 1919 decreased in quantity, and their total value was less than in 1918, as is shown in the following table:

Mine production of Goldfield district, Nev., 1918 and 1919.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	264,237	$1,212,572	90,560	548,847	.....	$1,438,697
1919	16,435	740,265	39,912	125,418	1,460	808,373
Increase or decrease, 1919	−247,802	−472,307	−50,648	−423,429	+1,460	−630,324
Total, 1904–1919	.....	82,205,014	1,337,185	7,539,123	27,540	84,493,782

Six producers reported the production of ore with an average value of $49.19 a ton, against an average of $5.44 in 1918. The larger part of this output, or 8,605 tons, was treated at milling plants by the cyanidation process and yielded 14,058.30 ounces of gold, 24,462 ounces of silver, and 833 tons of concentrate, which contained 1,849 ounces of gold, 4,748 ounces of silver, and 55,984 pounds of copper. The ore of shipping grade amounted to 7,830 tons and contained 19,903.03 ounces of gold, 10,702 ounces of silver, 69,434 pounds of copper, and 1,460 pounds of lead. Most of the output came from the property of the Goldfield Consolidated Mines Co., which was followed by the Florence, Great Bend (chiefly from the 160-foot level), Jumbo Extension, and Eagle.

Preparations were made by the Goldfield Development Co. for working the low-grade ores. The mill was overhauled, and as a preliminary to mining a headframe and hoisting plant were erected close to the old Combination shaft. The Atlanta Mines Co. abandoned its 1,750-foot level and restricted its work to an area accessible from the 1,465-foot level of the Grizzly Bear. Development work was done at the Florence, Red Hill, Cracker Jack, Kewanas, Merger, Spearhead, Silver Peak, Lone Star, and Blue Bell properties.

After having been large producers for 17 years, the mines operated by the Goldfield Consolidated Co. were turned over to lessees on February 1. From the organization of the company in 1906 to December 31, 1919, it has paid to the stockholders $8.20 a share, or a total of $29,177,789. The final report of the company [6] gives the conditions under which the property is leased as follows:

As indicated in the last annual report, it was found early in the year that it was not advisable to continue the operation of your property on company account, mainly for the reasons that the production of ore, not only from company corporations but also from lessees, was continually declining, with consequent prohibitive increase in the operating cost; and that the value of the ore produced was gradually decreasing, resulting in material loss each month.

Accordingly, on January 15, shipments of "copper ore" to the mill were suspended, and on January 31 all mining operations were discontinued.

After the treatment of the ore remaining in the mill had been completed all milling operations ceased, and a general clean-up of the refinery and interior of the mill was conducted on company account, the production from which yielded a net value of $124,671.56.

Following this, and to insure a thorough clean-up, a lease was granted for that purpose on the mill premises on March 23, for a period of one year. This lease has produced to date a net value of $78,600.43, of which your company has retained, as royalty, $42,834.39, making the total amount realized by your company during the year on all mill clean-up operations, $167,505.95.

Immediately following the cessation of mining operations a lease was granted to the Goldfield Development Co. on February 1, covering all of your mining property and equipment in the Goldfield mining district, for a period of five years, in consideration for which your company received a rental of $500 per month, together with royalties on the net returns from all ore shipped from the property by the lessee.

On July 1 a lease was also granted to the Goldfield Development Co., covering all of the milling plant of your company, for the period of three years, which may be extended to a period of five years, provided a definite quantity of ore is being treated in the mill at the end of three years.

From this lease your company is to receive as rental an amount based on the quantity and value of ore treated in the mill each month, but not less than $500 per month.

While no ore has been treated in the mill by the Goldfield Development Co., a considerable portion of the equipment has been overhauled and placed in condition for operation by that company.

[6] The Goldfield Consolidated Mines Co. Thirteenth Ann. Rept. for year ending Dec. 31, 1919.

During the year, before milling operations were discontinued, 8,590 tons of ore were treated in the mill, 2,375 tons of which were obtained from the storage of ore contained in the mill bins, and included in mill clean-up.

Since February 1 the Goldfield Development Co. has produced from the mine and shipped to smelters, 4,452 tons of ore, having a net value of $74,986.31, of which your company has retained as royalty, $13,143.49.

Of this amount of ore, 211 tons were produced from the property of the Goldfield Combination Fraction Mining Co., on which your company was granted a lease early in the year, for a period of five years, which was in turn subleased by your company to the Goldfield Development Co.

On account of the continued unfavorable economic conditions, no further resumption of the re-treatment of tailings was attempted during the year.

The Florence-Goldfield mine[7] produced 3,140 tons of gold-silver ore in 1919, valued at $85.60 a ton, through the operations of lessees, of which the Florence Divide Mining Co. had the largest production. The company report gives the following:

As a result of operations by lessees, shipments of a gross value of $268,794.71 were made during the year. After deducting $27.911.90 for freight and $23,741.25 for treatment charges, the net value of the ore shipped amounted to $217,141.56, of which your company received upwards of $50,000 in royalties.

Gold Mountain (Divide) district.—Three producers mined 9,725 tons of ore containing gold and silver, which was hauled by autotrucks and treated at cyanidation mills in the vicinity of Tonopah. The principal producers were the Tonopah Divide, Hasbrouck, and Divide Extension properties.

In August, according to various estimates, from 80 to 112 mining properties were in operation, and 93 hoisting plants were being installed daily. The number of men employed was estimated at 700 to 1,000, but the smaller figure is probably nearer the truth. Except for the Tonopah Divide and the Extension Divide properties, all the other so-called properties were declared prospects. Further information is given in a recent review[8] of the district.

In 1919 the Tonopah Divide mine[9] produced 9,611 tons of ore, containing gold and silver, valued at $282,107.83. The following statements as to the conditions at the property are taken from the annual report of the company:

The main vein has received most of the development work It is a mineralized fault fracture whose dip is nearly vertical and the strike northwest and southeast passing continuously through the property and into adjoining ground on either side. The enclosing rock is a rhyolite breccia, while in places a rhyolite dyke has been intruded along the fracture. Intense leaching accompanies the fault zone, which in places exceeds 100 feet in width. Leaching and oxidation continue unchanged to 585 feet, the lowest level yet opened.

While values as silver and gold occur in appreciable quantities throughout the veir zone, the payable ore, as shown by development to date, occurs irregularly as lenticular and chimney-shaped masses along the vein zone.

These ore bodies usually occur at points where there is strong cross fracturing.

The ratio of silver to gold is normally 250 to 1, except at points where the values occur in rhyolite; at such places they are chiefly gold. * * *

On the 370-foot level a crosscut has been driven southward for 426 feet to cut the downward continuation of the gold veins cropping in rhyolite near the summit of Gold Mountain. The crosscut reached the veins and crossed several seams which showed erratic uncommercial values. A drift has been extended 40 feet on the best-looking seam, but with negative results.

The shaft is now 645 feet deep and shows no change in formation. It is being deepened at the rate of one shift per day, making about 50 feet per month. This rate

[7] Florence-Goldfield Mining Co. Rept. for the year 1919.
[8] Young, G. J., Divide silver-gold district of Nevada: Eng. and Min. Jour., vol. 109, p. 62, Jan. 10, 1920.
[9] Tonopah Divide Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

seems most economical under the circumstances, since it is necessary to carry on lateral work in the upper levels and the present hoisting equipment is working at full capacity.

The entire mine has been carefully sampled during the past few months. Owing to the very erratic distribution of values and the lack of well defined vein walls the calculation of reserves is more than ordinarily hazardous. By assuming that the areas exposed in the different levels are representative of the ore bodies, and making nominal allowance for continuation beyond faces which expose a block only on one side and allowing a normal admixture of waste rock in mining, the developed and probable first-class ore at this time is 52,000 tons, averaging 20.00 ounces silver and 0.08 ounce gold, containing a total of 1,040,000 ounces silver and 4,160 ounces gold. The gross value at $1.25 silver will be approximately $1,385,000.

In addition, there is estimated as second-class material, including gold ore and dump, 16,000 tons, averaging 0.125 ounce gold and 5.12 ounces silver, or a total content of 2,000 ounces gold and 81,950 ounces silver. The gross value of this material is approximately $143,000, with silver at $1.25 per ounce.

No attempt is made in this report to estimate the net value of the ore reserve, since it can not yet be determined whether the ore will ultimately be shipped or treated on the property.

At present the ore is being hauled by auto truck to Tonopah and treated in a custom mill. It will be noted the cost is excessive, but it is thought the mine development has not yet progressed sufficiently to warrant the erection of a reduction plant at the mine.

Hornsilver district.—The Silver King mine yielded milling ore, containing principally silver, which was treated in a cyanidation plant, and some ore of shipping grade containing lead and silver.

Klondyke district.—Some silver ore and one lot of lead ore was shipped from the A. B. C. D. group to the smelter from Klondyke station, on the Tonopah & Goldfield Railroad.

Lida (Tule Canyon) district.—Three producers reported the output of 377 tons of ore, containing $329 in gold, 13,974 ounces of silver, 220 pounds of copper, and 49,193 pounds of lead, valued in all at $18,628. The Tip Top claim of the Ingalls group produced the largest quantity of ore, which was milled and produced lead concentrate containing silver and some gold, and silver bullion from cyanide operations. The Bullion property was a producer of lead ore containing lead and silver, which was concentrated in a plant equipped with a Herman ball mill. After spending about $6,000 in the development of a group of placer claims at the upper end of the canyon, the Tule Canyon Placer Association discontinued work, having failed to place the property on a paying basis. The Goldfield-Tule Canyon Placer Mining Co.,[11] operating the adjoining property, reduced its working force and continued on a small scale. The MacNamara mine, at Indian Gardens, 8 miles west of Lida, is reported [12] to have been reopened by the Allied Mining & Milling Co. The mine was discovered in 1880 and until 1903 was worked by the locator. Stopes show that a good production of lead-silver ore was made in the early days, and since 1916 three carloads of ore of a gross value of $5,000 have been shipped. The mine is opened through three tunnels and a shaft. The greatest vertical depth reached was 170 feet in a 330-foot crosscut tunnel, and a sample taken from a 10-foot face in a drift at this depth is said to have averaged a trace of gold and 15 ounces of silver a ton and 35 per cent of lead.

Lone Mountain district.—Lead ore, largely oxidized, was shipped from the Alpine property.

[11] Min. and Sci. Press, Oct. 11, 1919, p. 540.
[12] Idem, Dec. 6, 1919, p. 826.

Montezuma district.—The Arizona Bullion claims were operated in 1919, and a small output of lead ore containing silver was shipped directly to the smelter.

Silverpeak district.—The Blair Mines Co. operated a short time on the Pittsburg Silverpeak property, and after the shipment of some gold and silver bullion from the cyanidation of the ores the company was reported to have gone out of business. However, certain development work was continued by lessees on some of the mines in the district.

Tokop district (Bonnie Clare).—Lead ore of smelting grade, containing gold with a little silver, was shipped from the Courbet property.

EUREKA COUNTY.

Mine production in Eureka County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	36	4,936	$35,713	66,977	67,618	1,197,292	$204,430
1919	20	3,428	22,621	69,523	40,713	1,179,723	170,585
Increase or decrease, 1919	−16	−1,508	−13,122	+2,546	−26,905	−17,569	−33,845

[a] Includes placer production.

Of the ore mined in Eureka County in 1919, first-class ore amounting to 2,360 tons, shipped directly to smelters, contained $17,257 in gold, 67,368 ounces of silver, 6,595 pounds of copper, and 1,129,325 pounds of lead, valued in all at $153,790, or an average of $65.17 a ton. Placer bullion reported from four sources amounted to $570 in gold and 2 ounces of silver.

Cortez district.—Silver ore from the Liberty Bell mine was shipped directly to the smelter.

Eureka district.—Fifteen producers reported the production of 3,283 tons of ore and sorted matte from old slag, all of which was shipped directly to the smelters. The output contained $20,988 in gold, 66,459 ounces of silver, 40,713 pounds of copper, and 1,179,723 pounds of lead, valued in all at $165,520. Lead-silver ore was produced from the Eureka Croesus, Holly, Silver Lick, Cyanide, Distinction, Helen Mortimer, Jackson, Lucia Tuffa, and Phoenix Silver mines. The old slag worked over at the Richmond-Eureka smelter dump is largely speiss containing lead, copper, silver, gold, and arsenic, which is shipped to Midvale, Utah.

The Richmond-Eureka mine,[13] which was closed several years ago, remained idle during 1919. The company's report says that the mine has, above the water level, large reserves of low-grade fluxing ore, which, under present costs of mining, transporting, and smelting, are of noncommercial grade.

The Eureka & Palisade Railroad was purchased by interests connected with the Eureka Croesus Mining Co., and another locomotive

[13] United States Smelting, Refining & Mining Co., Fourteenth Ann. Rept., for year ending Dec. 31, 1919.

to be used in hauling general freight and ore was added to the equipment.

The winze from the 400-foot level of the Eureka Croesus mine is 275 feet deep, and ore reported to assay $200 a ton in lead and silver is being shipped from it. The vein is said to be 40 feet wide, and the ore is being broken over a width of 20 feet.

Lynn district.—Very little work was done in the Lynn district, except that which was carried on by agents in search of purchasable property. The entire output of the district, consisting of gold and silver, was valued at $1,601, of which $572 was the value of placer gold sold to dealers. A small quantity of gold ore was shipped to the smelter from the Lynn Big Six mine, where a milling plant equipped for amalgamation was erected in 1917, but was not operated in 1919. This mine was the only quartz property operated in 1919, and it has reached a greater depth than any other in the district. It is opened by a shaft to a depth of 200 feet, and work has been done on both the 100 and 200 foot levels. According to Lincoln,[14] placer deposits are found in the neighborhood of the center of mineralization. The gold is evidently derived from the erosion of gold of the lodes, and in two of the creeks bismuth oxide was found in association with the placer gold just as it had been found with the lode gold. The placers are rich but narrow and thin and in places covered with heavy burden. The placer gold is coarse, rough, and pure. Nuggets suitable for charms are frequently found, and gold colors are so large and thick that they can be panned with great facility. The coarseness and roughness of the gold and the frequency with which it is found attached to particles of lode matter or country rock indicate that it has not traveled far. Three placer-mining methods have been employed in the Lynn district—shoveling into cradles, shoveling into small sluices, and shoveling into dry placer machines. The dry placer machine has not proved successful, as its tailings show high value on panning, indicating that the extraction has been poor. The rocker does good work and requires little water, an especial advantage in this district, where the water supply is meager.

Mineral Hill district.—Only one producer, against five reporting in 1918, shipped silver ore, which was from the Mineral Hill Consolidated property.

HUMBOLDT COUNTY.

Humboldt County was recently divided into two counties, and the portion now known as Pershing County has the greater part of the mining output.

In 1919 producers of shipping ore and bullion from 13 properties reported an output of 218 tons of ore containing gold, silver, copper, and lead, valued in all at $29,756, or an average of $136.49 a ton. Placer output was reported only from the Gold Run district, and amounted to $896 in gold and 8 ounces of silver.

Gold Run (Adelaide) district.—Small quantities of ore were shipped by four producers, the Caroline property yielding copper ore and the Black Diamond and Silver Shield yielding lead ore containing silver. Placer gold amounting to $896 was also reported in 1919.

[14] Lincoln, F. C., unpublished notes on the placers of the Lynn district, Oct. 23, 1919.

National district.—A very small output of gold and silver was produced by five operators, chiefly the National, Buckskin National, and Halcyon mines.

Red Butte district.—A lot of silver ore, containing a little lead, was shipped from the Silver Cloud claim, near Pronto, on the Western Pacific Railroad.

Warm Springs district.—A new milling plant was reported under construction in December on the Ashdown property. The mine is opened by ten tunnel levels, each of which is said to have an exposure of gold and silver ore.

Winnemucca Mountain district.—Only one small shipment, consisting of lead ore containing silver, was made from this district.

LANDER COUNTY.

The ore of shipping grade mined in Lander County in 1919 amounted to 3,084 tons, containing $22,930 in gold, 65,044 ounces of silver, 277,332 pounds of copper, and 339,459 pounds of lead, valued in all at $165,355, or an average of $53.62 a ton. The placer output reported by eight operators was $49,183 in gold and 319 ounces of silver, against a production in 1918 by six operators of $76,279 in gold and 490 ounces of silver.

Battle Mountain district.—The output of the district was valued at $118,106, which was reported by nine producers of ore and eight producers of gold bullion recovered from placer operations. The ore mined aggregated 3,544 tons and contained $1,834 in gold, 14,884 ounces of silver, 254,860 pounds of copper, and 50,145 pounds of lead, valued in all at $68,566. The gold and silver bullion produced from placers amounted to $49,183 in gold and 319 ounces of silver. Most of the ore produced came from the Copper Basin and Nicklas properties. At the Nicklas sulphide ore containing gold and silver was treated in a small experimental concentration plant. Shipments of ore were also made from the Elder Creek, Copper Queen, Contention, and Moonlight properties.

Bullion district.—Shipments of ore made by five producers aggregated 183 tons, containing gold, silver, copper, and lead valued at $16,272. Most of the ore was produced from the Maysville, a silver mine, operated by lessees. Small shipments of ore were also made from the Silver Prize, Gold Quartz, and Clipper properties.

Cortez district.—The Utah mine produced oxidized lead ore containing silver.

Hilltop district.—Five producers reported the output of 938 tons of ore of shipping grade, containing $22,278 in gold, 28,028 ounces of silver, 21,500 pounds of copper, and 268,039 pounds of lead, valued in all at $71,874. The largest producer was the Kimberly Consolidated mine, which yielded oxidized copper ore, containing silver and gold, and lead-silver ore, containing much gold. The Havedon Eagle property, on Gray Eagle Mountain, yielded a car of oxidized lead ore. Shipments of silver ore were also made from the Pittsburg Red Top, and some ore was shipped from the Jenkins group.

Lewis district.—The Eagle Monitor property yielded a car of silver ore, containing a little copper.

Reese River district.—Four mine operators reported the output of 55 tons of ore, containing principally silver, valued at $4,557. Silver

ore was shipped from the Austin Dakota property, which was the largest producer. Smaller quantities of ore were shipped from the Austin Manhattan mine and the Switzerland claim.

LINCOLN COUNTY.

Mine production in Lincoln County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	12	115,001	$23,187	421,310	439,767	8,893,658	581,718	$1,237,505
1919	17	96,675	27,495	457,152	115,539	7,051,388	78,200	940,426
Increase or decrease, 1919..	+5	−18,326	+4,306	+35,842	−324,228	−1,842,270	−503,518	−297,079

The greater part of the ore (96,152 tons) mined in Lincoln County in 1919 was of shipping grade and contained $26,998 in gold, 454,018 ounces of silver, 114,949 pounds of copper, and 6,979,218 pounds of lead, valued in all at $926,777, or an average of $9.64 a ton. At concentrating plants 498 tons of ore yielded 249 tons of concentrates, containing $372 in gold, 3,120 ounces of silver, 590 pounds of copper, 72,170 pounds of lead, and 78,200 pounds of zinc, valued in all at $13,510, or an average of $54.26 a ton. No placer production was reported in 1919.

Comet district.—Lead ore from the Stella property and some silver ore, containing lead, from the Lyndon claim, comprised the output of the Comet district.

Freiberg district.—A little oxidized iron ore, containing silver and lead, was shipped from the Roadside property.

Jack Rabbit district.—Three producers reported the output of 8,288 tons of ore, containing $1,745 in gold, 74,242 ounces of silver, 106,582 pounds of copper, and 100,738 pounds of lead, valued in all at $110,059. Oxidized lead ore and considerable oxidized iron ore, carrying silver, copper, and lead, was shipped from the Black Metals mine. Notable shipments were also made from the E. & F. property. Some oxidized copper and lead ore was shipped from the Bristol mines.

Pioche district.—Eleven producers reported 88,162 tons of ore, of which 87,639 tons was shipped directly to the smelters and 498 tons was reduced to a lead-zinc concentrate. Some gold and silver bullion was recovered from the amalgamation of a small quantity of gold ore. The total output of the district contained $25,523 in gold, 366,634 ounces of silver, 8,251 pounds of copper, 6,917,087 pounds of lead, and 78,200 pounds of zinc, valued in all at $810,003. Most of the ore shipped was mined from the Prince Consolidated property, which produced considerable sulphide lead ore and oxidized iron-manganese ore. The output of the Virginia-Louise mine, the next largest producer, consisted of oxidized iron-manganese ore.

The current price of silver rendered possible the exploitation of bodies of low-grade ore that could not have been profitably mined previously. A considerable proportion of the lead and silver in the ores of the Pioche district occurs in oxidized form, and under the ore-

dressing methods of amalgamation and table concentration formerly practiced rarely more than 50 or 60 per cent of the metal contents could be recovered.

The ore of the Prince Consolidated and Virginia-Louise mines is a low-grade silver-lead ore, which, because of the fact that it contains between 30 and 40 per cent of iron and manganese in excess of insoluble content, is a desirable flux for smelting. The two properties are contiguous and are mining the same ore bodies, which are of the bedded type and are extensive and thick. The shaft of the Prince Consolidated mine had reached a depth of 400 feet in September. It is planned to sink 500 feet farther to open an ore body discovered in drilling, and later the shaft may be sunk to a depth of 1,300 feet to open a second vein found in drilling. The drill penetrated the first vein for 10 feet and the second one for 11 feet. The first vein contained 25 ounces of silver and $3 in gold a ton; the second 30 per cent of zinc. Regular shipments of ore aggregating 2,000 tons a week were made throughout the year.

Lessees actively operated the Amalgamated Pioche property, and silver ore and sulphide lead ore were mined during the year, the largest operator being the Combined Metals Corporation. Other producers of note were the Volcano, Mendha, Yuba East, and Poorman groups.

LYON COUNTY.

Mine production in Lyon County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1918	44	414,287	$71,860	52,442	17,138,747	$4,357,573
1919	24	109,898	[a] 79,367	[a] 62,860	3,076,647	722,026
Increase or decrease, 1919	−20	−304,389	+ 7,507	+10,418	−14,062,100	− 3,635,547

[a] Includes placer production.

In Lyon County 8,739 tons of ore and 15,270 tons of old tailings were treated at amalgamation and cyanidation plants and yielded $78,672 in gold and 58,911 ounces of silver, valued in all at $144,652, or an average of $6.02 a ton. At one leaching mill in the county some copper ore was treated by the sulphuric acid process. Ores of shipping grade, amounting to 41,949 tons, were shipped to smelters and produced $33 in gold, 2,945 ounces of silver, and 1,842,284 pounds of copper, valued in all at $345,996, or an average of $8.25 a ton.

Silver City (Palmyra) district (Dayton and Como).—Eleven producers reported 23,974 tons of ore and old tailings, containing $78,423 in gold and 58,787 ounces of silver, valued in all at $144,264. There were 8,739 tons of ore milled and 12,235 tons (estimated) of old tailing re-treated. The principal producer of ore was the Como mine, which is reported to have operated continuously, but the cyanidation mill on the property was active only 180 days. The largest tailing operations were at Silver City, and some tailings were re-treated from the

old dumps at Dayton. Most of the ore from the vicinity of Silver was produced from the Haywood, Oest, and Silver King mines.

The property of the Como Consolidated Mining Co. is at the edge of the district, about 12 miles southeast of Dayton, the nearest railway point. The mill was remodeled and enlarged to treat the ores from the Como-Eureka, North Rapidan, and Lucky Sunday mines. The ore occurs in hard quartz with small quantities of calcite and other minerals. The valuable metals are gold and silver in approximately equal proportions, and both are so minutely disseminated that fine grinding is essential. A complete description of the mill with flow-sheet was recently published.[15]

Yerington district.—Twelve producers reported 85,924 tons of ore, containing $281 in gold, 4,069 ounces of silver, 3,076,647 pounds of copper, valued in all at $577,094. The largest part of the ore produced, or 42,758 tons, was concentrated, yielding copper concentrate, and 41,949 tons of copper ore of smelting grade was shipped to the smelters. There was also 1,182 tons of copper ore leached. Most of the district's output of ore was mined from the Bluestone property. Part of this ore was treated in the company's 700-ton ball mill and flotation plant, which was active for seven months. Some of the ore from this mine was shipped directly to the smelters at Thompson, Nev., and near Salt Lake City, Utah. The Mason Valley mine was active for a time, but its smelter at Thompson was closed early in the year. As a result, other mines in the district were compelled to curtail shipments or ship the ore to smelters in Utah. Other producers of the district were the Empire Nevada, Nevada Douglas, and Malachite mines.

At Thompson the Mason Valley copper furnaces [16] were closed on March 1 after two months' operations, during which 44,543 tons of ore and metal bearing fluxes were smelted—15,894 tons from the company's property, or from properties held under option, and 28,649 tons from outside sources. Bullion produced during this period contained 238.66 ounces of gold, 22,409.63 ounces of silver, and 2,097,772 pounds of copper. Referring to the copper property at Mason Valley, the company's printed report contains the following:

> Shipments ceased late in February, but development work has been carried on continuously. A great deal of the work has been done in the main ore zone in the south end of the mine, above the No. 3 level, in blocks 81, 82, 87, 88, and 106. This ground has opened up well. Most of the other work has been done below the 400-foot level, in fact the major portion below the 470-foot level in blocks 89 and 90. This development shows that below the 470-foot level the ore zone flattens greatly in dip. The work has not progressed far enough to prove the limits of the ore, either in dip or strike. The development to date leads to the belief that further work in this zone may add materially to the life of the mine, though the ore is likely to be of lower grade than that above the 400-foot level.

According to a recent report,[17] the Mason Valley Mines Co. petitioned the railroad commission in Carson City for adjustment of the rates on ore to the Thompson smelter. The mining company stated that it wished to make a custom smelter out of its plant and to add reverberatory furnaces so that concentrates could be treated. The quantity of oxidized ore in the district is rapidly becoming

[15] Borzynski, F., The Como Consolidated mill: Min. and Sci. Press, vol. 120, p. 55, 1920.
[16] Mason Valley Mines Co. Tenth Ann. Rept., for year ending Dec. 31, 1919.
[17] Min. and Sci. Press, Oct. 18, 1919, p. 580.

smaller, and future operation of the smelter will depend on its ability to handle sulphide ores and concentrates.

MINERAL COUNTY.

Mine production in Mineral County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	85	157,135	$578,925	351,760	2,228,337	171,660	$1,493,272
1919	42	18,929	191,219	84,240	296,815	65,204	344,232
Decrease, 1919	43	138,206	387,706	267,520	1,931,522	106,456	1,149,040

[a] Includes placer production.

At the Mineral County gold and silver mills 13,432 tons of ore was treated in 1919, most of it by cyanidation, which yielded $165,461 in gold and 7,276 ounces of silver, or an average of $12.93 a ton; and there were shipped to smelters, 5,497 tons of crude ore, which contained $24,820 in gold, 76,936 ounces of silver, 296,815 pounds of copper, and 65,204 pounds of lead, valued in all at $169,652, or an average of $30.86 a ton. The output reported from five placers amounted to $937 in gold and 28 ounces of silver, against $983 in gold and 48 ounces of silver in 1918.

Bell district (Mina, Omco).—There were only two producers in the Bell district in 1919, the Olympic and Fagan properties. The Olympic produced bullion from gold and silver ore treated in a 75-ton cyanide plant, which operated until November 21, when it was completely destroyed by fire. The mine is opened by an inclined shaft 200 feet deep, and ore sufficient to justify the rebuilding of the mill is said to be in sight. Development work in the mine was carried on during the remainder of 1919. The Fagan property produced oxidized lead ore of shipping grade containing silver.

The Simon lead mine,[18] which is reported to have ore reserves of at least 400,000 tons, continued development work in the property throughout 1919 as well as the testing of ores for a suitable process of treatment. The following paragraph is taken from Walter Harvey Weed's statement in the company's printed report:

> The Simon property is a young mine, in which deposits of silver-lead-zinc sulphide ore occur as replacements of limestone and to some extent of quartz porphyry. The ore bodies are large and of that type which may develop laterally and vertically into deposits comparable in magnitude with those of Eureka, Nev., or Tintic, Utah. The apparent constriction on the sixth level is probably local, and on this level the high-grade ore found in the north ore body offsets the apparent decline in value of the ore of the south ore body, which may be due to a rake of the ore body or to a diffusion of the mineralizing solutions at this level through fractured porphyry.

Buena Vista district.—Silver ore was shipped to the smelter from the R. & S. property.

Columbus district.—In cleaning up the old Candelaria mines the syndicate operating them shipped from the Lucky Hill claim con-

[18] The Simon Silver Lead Mines Co. Ann. Rept. for year ending Dec. 31, 1919.

siderable silver ore containing gold. Some lead ore, containing silver and gold, was produced from the Mount Potosi, Savage, and Munck properties.

Garfield district.—Copper ore containing silver was shipped to the smelter from the Silversides group.

Hawthorne district.—Eight producers shipped 59 tons of ore, containing principally silver with some copper and lead and a little gold, valued at $4,556. Some of the shippers of this output were the Garfield, Gold Bug, Albert, and Silver King.

Pinegrove district.—A clean-up of the old cyanide plant of the Rockland property was reported to have been shipped to the smelter, and some gold and silver bullion was recovered by a lessee from the ore mined from the Wheeler property.

Rand district.—Four producers reported the production of 189 tons of ore, containing silver, copper, and gold, valued at $13,828. Construction was started in December at the Gold Pen property on a 20-ton amalgamating plant using a Kincaid mill. Some high-grade ore was treated at a refinery in Los Angeles, Calif., where gold and silver bullion was recovered. Gold ore from the Nevada Rand mine and a small quantity of copper ore from the Jumbo Copper lease were shipped to the smelter at Kennett, Calif.

Rawhide district.—Of the ten producers in the district, five reported production from surface mining. The total output reported amounted to $29,512, which included the content of 199 tons of ore, from which was recovered $14,015 in gold and 12,972 ounces of silver, valued in all at $28,544. Shipments from the Mascot and Jack Pot properties and ore cleaned up by lessees comprised the output of the district.

Santa Fe district (Luning).—The output of the district was given incorrectly in the 1916 report of Mineral Resources. In the following table the error is corrected:

Mine production in Santa Fe district, Mineral County, Nev., 1915–1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1915	20	2,726	$2,987	6,802	384,258	3,468	$73,844
1916	19	17,665	1,222	46,755	2,547,058	.....	658,563
1917	49	19,932	2,009	50,007	2,590,756	35,799	753,570
1918	25	12,897	953	42,012	1,923,259	18,011	519,289
1919	4	534	3	2,008	85,470	.....	18,149

Four producers reported the shipment of 534 tons of ore in 1919, valued at $18,149. The ore produced was from the Paymaster, Champion, and Turk properties.

Silver Star (Marietta) district.—Six producers reported the shipment of smelting ore aggregating 439 tons and carrying gold, silver, copper, and lead valued in all at $9,493. Shipments were reported from the Dunlap mine, Ibex, Silver Gulch, Blue Jacket, and Black Mountain Silver properties.

Walker Lake district.—The Northern Light mine,[19] 20 miles west of Yerington, was taken under option in April by the Mason Valley Min s Co. Work was commenced shortly afterward and continued until the end of the year, but was stopped in March, 1920. Under the terms of the lease and option 2,800 tons of copper ore, containing an average of 4.8 per cent of copper, was shipped to the smelter at Thompson.

NYE COUNTY.

Mine production in Nye County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	109	552,081	$1,991,845	6,104,711	8,540	461,912	$8,131,674
1919	66	340,768	1,537,980	3,622,680	15,370	55,272	5,601,170
Increase or decrease, 1919	−43	−211,313	−453,865	−2,482,031	+6,830	−409,640	−2,530,504

[a] Includes placer production.

The output of ore in Nye County reported by 50 operators of deep mines was 211,313 tons less than was reported by 79 operators in 1918. The total average value per ton increased from $14.47 in 1918 to $16.20 in 1919. The value of the ore in both years was practically that of the gold and silver. At gold and silver mills 334,426 tons of ore and 5,732 tons of old tailings were treated and produced bullion containing $1,447,613 in gold and 3,531,676 ounces of silver, having an average value per ton of $15.88, and 378 tons of concentrates, which were shipped to smelters, and contained 408.72 ounces of gold and 60,156 ounces of silver. No ore was treated at concentration mills. The ore of shipping grade amounted to 610 tons and contained $3,275 in gold, 28,849 ounces of silver, 15,370 pounds of copper, and 55,272 pounds of lead, valued in all at $41,374, or an average of $67.83 a ton. The placer output reported by 16 operators amounted to $78,644 in gold and 1,999 ounces of silver, against a production in 1918 of $138,090 in gold and 3,339 ounces of silver.

Bellehellen district.—Four producers reported the production of 262 tons of ore, part of which was treated at a custom mill at Tonopah and produced silver bullion. The total content of the output was $2,070 in gold and 12,518 ounces of silver, valued at $16,090. The Bellehellen property was operated by the Pacific States Mining & Milling Co. up to the last few months of the year, when it was closed indefinitely. Some gold bullion containing silver was also recovered from the ore of the Clifford mine treated at a mill on the property. The Gazabo group was operated under lease and produced a small quantity of silver ore containing gold.

Bullfrog district.—Lessees working at the Montgomery-Shoshone mine shipped to the smelter a few tons of silver ore containing gold, and the Consolidated Mayflower property produced some gold and silver bullion from ore taken out in development. The work reported

[19] Mason Valley Mines Co. Tenth Ann. Rept., for year ending Dec. 31, 1919.

to have been done on the second, fourth, and fifth levels of the mine amounted to 2,500 feet.

On December 26, 1918, work was resumed at the Mayflower mine. All mine and shaft timbering had been destroyed in 1912. Repairs were recently made, and milling ore said to assay from $15 to $35 a ton in gold and silver has been opened. The ore is oxidized and free-milling down to the 500-foot level, which is 10 feet above water level. Records of former production are incomplete but show a net profit of $158,000 from 11,053 tons of ore mined. While operated mining costs averaged $2 and milling costs $3.53 a ton. The 15-stamp mill on the property was remodeled and increased by the addition of a ball mill. A description of the mill is given in an article[20] published in 1919, with the following notes referring to the development of the mine:

The geology is described as a readily distinguished series of rhyolite flows, in part brecciated and with strata, varying greatly in width, of red volcanic mud. A number of fault planes are observed, but displacement is negligible. The ore channel is a fissure striking N. 55° W. and dipping southwest from 60° to 70°, and averages 5 feet in width. The Starlight incline shaft, 1,400 feet northwest of the main shaft, was sunk 93 feet in ore of milling grade, and a hanging-wall crosscut on the 85-foot level, out 30 feet, exposed 6 feet of $12 ore in a parallel vein. Near this shaft the vein was sampled for 60 feet by 3-foot cuts at 3-foot intervals, giving an average of $51 per ton. A winze from the 400-foot level of the main shaft was sunk 80 feet in ore assaying from $12 to $25 per ton. The vein was cut recently on the 500-foot level, where it was 12 feet wide, with 18 inches of ore on the hanging wall assaying $30 per ton. Winzes are to be sunk from the 500-foot level to determine the character of the ore below water level.

The Reorganized Pioneer Mines Co. retimbered the old shaft to a depth of 400 feet and continued sinking to a depth of 800 feet. The mine has produced about $600,000 from shipments of ore and bullion.

Cloverdale district.—The Rosalie property yielded some milling ore, from which silver bullion was recovered, and shipments of oxidized lead ore were made from one of the claims in the district by lessees.

Johnnie district.—The amalgamation mill of the Johnnie mine was operated during part of the year, and some gold and silver bullion was shipped to the mint at San Francisco. A small production of gold bullion was also reported from the treatment of ore produced on the Eureka Johnnie property.

Mammoth district (Lodi).—The Illinois lode was operated by the United Lodi Mines Co. and other lessees in 1919, and a small quantity of lead ore, containing silver and a little gold, was shipped from the property.

The mining camp of Lodi is an old one. The principal mine is opened to a depth of 1,000 feet on a vein in limestone close to a contact of the limestone and granite. Some good ore was developed, but attempts made in 1908 to treat it locally in a lead blast furnace were unsuccessful. The property remained in a dormant state until the price of silver became high enough to make the ore attractive. In 1919 a high-grade concentrate was made from the ore, and the tailings, containing silver, were said to be treated by cyanidation. The experimental mill consisted of a rock crusher, ball mill, 20 and 40 mesh screens, and Overstrom and Senn concentrating tables. Transportation is effected by 2½-ton autotrucks from Luning, 40

[20] Min. and Sci. Press, vol. 118, p. 193, Feb. 8, 1919.

miles distant. Water is received through a 3-inch pipe line 5 miles long.

Manhattan district.—Ten producers reported 56,085 tons of ore and old tailings, all of which, except 2 tons shipped to the smelter, was of milling grade and resulted in a recovery of $269,750 in gold and 1,379 ounces of silver, valued in all at $271,295. The White Caps, Big Pine, and Jumping Jack mines were the principal producers of ore. Fourteen placer operators reported the production of $32,663 in gold and 723 ounces of silver. Most of the gold was recovered by drift mining and sluicing the gravel from the September, Top Knob No. 2, Thursday Fraction, Little Gray, Evening Star, Edith, China, and Bulldog placers.

Philadelphia or Belmont district.—The Monitor Belmont property was under lease in 1919, and some prospecting work was done, but as the results were not satisfactory the work was abandoned. A small shipment of silver ore was made from the property. Some old tailing from the Eldorado South mine was treated, and silver precipitates from the cyanide operations were shipped to the smelter.

Reveille district.—Some ore from the Southwestern Nevada property was shipped to the mills at Tonopah and silver recovered.

Round Mountain district.—Five producers of ore reported 11,919 tons, containing $402,354 in gold and 11,430 ounces of silver, valued in all at $415,156. Two placer producers reported gold in bullion amounting to $45,981 and 1,276 ounces of silver. Most of this was produced from the placer property of the Round Mountain Mining Co.

The Round Mountain Mining Co.[21] added to its property by acquiring the Reo and Merry Xmas lode claims, containing 37.24 acres; the Safe, Safe No. 2, Victory, Victory No. 3, Victory No. 4, Victory No. 5, Bull, Money-Maker, and Mineral Farm Association placer claims, containing 940 acres; the placer rights of the Homestake group of four claims, containing 71.4 acres; and the placer rights of the Blue Jacket, and Alta groups, containing 144.85 acres. Further information taken from the company's annual report is as follows:

> During 1919, 62,640 cubic yards of placer gravel were moved by hydraulicking, yielding 3,592.35 ounces of bullion, having a value of $46,258.32. In addition, $462.16 was received in royalties from placer leases. The total operating cost was $39,736.62 and the net realization $6,983.86. On account of the water shortage, bedrock sweepings, the cost of which are included in the 1919 costs, were not sluiced.
>
> The gross value recovered, exclusive of placer lease royalties, was 0.7385 cent per cubic yard; operating cost, 0.6344 cent per cubic yard; and the realization, 0.1041 cent per cubic yard. * * *
>
> The placer water season was very short and unsatisfactory. The months of March, April, and May were dry and hot, making an exceedingly fast "run-off," the water in the canyons during April being many times the capacity of the pipe lines. By the 10th of June there was barely sufficient water to sluice the bedrock sweepings, and by the end of July, Jefferson and Shoshone canyons were dry and the Jett water had to be used in operating the mills. Such a condition was never before known in the history of the Round Mountain section. * * *
>
> The production of the lode lessees of the Round Mountain Mining Co. for the year 1919 was 2,967 tons, of which 2,718 tons were milled in 1919 and 269 tons are ready for milling in 1920. The 2,718 tons yielded 8,543.81 ounces of bullion, having a value of $112,623.14, or $41.436 per ton. * * * The company received in royalties from these operations $25,350.94, or $9.327 per ton; to this should be added the milling charge of $1.00 per ton, making the total revenue from the lessees $28,070.94. The 259 tons ready for milling have a value of $14,000, or $54.05 per ton.

[21] Round Mountain Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

The production of the lessees from the vein on top of Round Mountain was 362 tons, of a value of $49,687.25, or $137.257 per ton. These leases were granted along the vein for a distance of 700 feet, and to a depth of 50 feet, ore showing in the bottom of the lease workings at this depth. This vein is situated in an unexplored portion of the property. * * *

On December 7 the mill was started on company ore, two shifts being run. Five hundred and sixty tons were mined and milled in December, the gross value being $3,518.10, or $6.283 per ton; tailings loss $285.60, or 51 cents per ton, the recovered value being $3,232.50, or $5.773 per ton. Only the Huntingtons and the tube mills were operated.

The Fairview Round Mountain Mines Co.[22] again added to its holdings by acquiring the Lone Pine patented lode claim and the Mother Lode, Mother Lode No. 1, Empire, Empire No. 1, Empire Fraction, Nellie, and Lincoln Fraction unpatented lode claims. These claims lie north and east of the Fairview claim and contain 112.281 acres. The company now owns 172.727 acres, of which 39.41 acres is patented. The following paragraphs are taken from the company's printed report:

As in 1918, the principal mining operations were carried on in the Fairview claim. 8,692.9 tons of ore having a gross value of $311,757.18 were mined and milled. The bullion produced yielded $296,465.77, representing an extraction of 95.1 per cent, an increase in extraction of 2 per cent over 1918. The gross value per ton was $35.8634, tailings loss $1.7591, net value per ton $34.1043. The total operating cost, exclusive of depreciation and depletion, was $119,810.84, or $13.78 per ton, of which amount $22,023.02, or $2.53 per ton, was for milling.

3,252 feet of development work was performed during the year at a cost of $3.09 per ton or $8.2856 per foot. In addition, 130 feet of the Daisy shaft was restored and retimbered and the shaft sunk a further depth of 140 feet at a cost of $12,503.16, or $1.4383 per ton of ore produced. At a point 250 feet below the collar of the shaft a station was cut and lateral work commenced. The company now has a well-timbered, centrally located shaft, convenient to the mill, through which the lower levels can be explored.

During the year, 18,110 tons of waste were placed on the dumps, of which 5,244 tons were taken from the Daisy shaft and the laterals therefrom, 6,837 tons from the stopes, and 6,029 tons from development work in the levels above the shaft. * * *

The mill was in continuous operation during the year. Plans have been made to increase the capacity to 50 tons per day by the addition of a 6-foot Hardinge pebble mill. The mill building has been enlarged so that immediately upon receipt of the necessary machinery from the manufacturers the mill can be started on the increased tonnage basis.

In July, 1919, the Fairview Extension Mining Co.[23] was organized and acquired the lode rights of the Shot, Blue Jacket, and Alta groups, comprising 182.10 acres. The Shot group of three claims, containing 37.24 acres, is patented. In December 102 tons of ore was milled at the Round Mountain mill, giving a net recovery of $1,532.09. This was obtained from a so-called waste dump left by a former lessee of the Blue Jacket Co.

Most of the area owned by this company lies contiguous to and east of the property of the Round Mountain Mining Co., also contiguous to and southeast of the Fairview Round Mountain Mines Co. The east margin of the property is marked by the granite-rhyolite contact trending at this point in a north and south direction. Running east and west through the property is a broad zone of sheeted and highly silicified rhyolite, reaching a maximum width of 1,000 feet. This zone strikes almost due east and west with a slight dip to the south, characteristic of practically all of the productive zones of the district. Most of the values are obtained from stringers in this sheeted zone and many of these stringers were successfully worked by lessees in the early days of the camp. An indication of the possibilities of the property is that in screening a waste dump left by one of these lessees, a product averaging $8.50 per ton was obtained.

[22] Fairview Round Mountain Mines Co. Ann. Rept. for year ending Dec. 31, 1919.
[23] Fairview Extension Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

San Antone district.—The Best Chance property of the Hudson Leasing Co. produced some lead ore shipped to San Francisco and some gold and silver milling ore shipped to a cyanidation plant at Tonopah.

TONOPAH DISTRICT.

Mine production of Tonopah district, Nev., 1904–1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	24	501,190	$1,287,745	5,929,920	.....	.....	$7,217,665
1919	14	268,658	771,804	3,568,875	.....	.....	4,768,944
Decrease, 1919	10	232,532	515,941	2,361,045	.....	.....	2,448,721
Total, 1904–1919	.....	5,553,574	27,032,281	123,465,208	12,113	214,523	104,320,584

All the ore produced in the Tonopah district was milled in the four cyanidation plants at Tonopah—the Belmont, West End, Extension, and MacNamara. These mills produced silver bullion containing gold and some concentrate containing gold and silver, which was shipped to the smelter. There was also 2,149 tons of old tailings re-treated.

With the exception of the time lost on account of the labor strike, which lasted nearly three months, these mills operated continuously, though some were operating at reduced capacity in December. In March the Tonopah Mining Co. abandoned the Desert mill at Millers, and the ore from its mine was treated at the Belmont mill.

Nearly all the 268,658 tons of ore mined and treated in the Tonopah district produced gold and silver bullion at cyanidation plants, some of which were equipped for concentration, recovering 378 tons of iron sulphide concentrate containing gold and silver. The mill bullion contained 36,927.33 ounces of gold and 3,508,719 ounces of silver, and the concentrates contained 408.72 ounces of gold and 60,156 ounces of silver. No crude ore was shipped from the district. The average bullion recovery per ton of ore and old tailings cyanided was $17.47, and the average value of the concentrates was $200.59. The chief producers of ore, named in order of production, were the Tonopah Belmont, Tonopah Extension, Tonopah Mining, West End, Montana Tonopah, MacNamara, and Jim Butler companies.

The general method of smelting gold-silver precipitates, recovered from cyanidation of the ores, is given in a recent article.[24] The method is much the same at each of the four plants operating.

From the Belmont mine [25] 79,687 dry tons and 64 tons of stock ore were treated at the Tonopah mill by cyanidation and concentration, yielding gold and silver bullion valued at $1,231,482.59. The total metal losses in tailing and concentrate amounted to $1.34 a ton. Mining cost $4.729; milling, $3.198; marketing bullion and other products 28.6 cents; these items, with general expenses, amounted to $9.09, leaving a profit of $5.108 a ton. The company report contained the following paragraphs:

[24] Young, G. J., Precipitate smelting at Tonopah: Eng. and Min. Jour., vol. 108, p. 892, 1919.
[25] Tonopah-Belmont Development Co., Seventeenth Ann. Rept., for year ending Dec. 31, 1919.

Because of a strike by the miners of the Tonopah and Divide districts, continuous operations covered but ten months of the year. The operations of the Belmont mine and mill were suspended from August 18 to October 15 and for a considerable further period mine production was curtailed.

Aside from the suspension of operations due to the strike, only minor interruptions occurred. The Tonopah mill treated, in addition to 79,687 tons of Belmont mine ores, 53,645 tons of custom ores. The net Tonopah earnings from Belmont mine ore were $405,428.42. Royalties from leases on mill tailings and mine dumps were $5,080.86. From the milling of custom ores a profit of $5,092.90 accrued. The net Tonopah earnings from the treatment of sweepings were $13,895.95. The realization from the final clean-up of the Millers plant was $4,034.13. The total realization from Tonopah operations was $433,532.26. Extraordinary expenses accrued by reason of the strike and not included in the above, were $23,432.61. * * *

The mine production of crude ore was 91,857 wet tons and from this, 9,580 wet tons, or 10.4 per cent, was sorted out as waste. The remaining 82,277 wet tons, containing 3.82 per cent moisture, or 79,132 dry tons, were milled. In addition, 491 dry tons from old mine dumps and 64 dry tons from ore stock, were milled. The total rock—ore and waste—broken in the mine for the production of the above tonnage was 102,351 wet tons.

The gross value of the 79,751 dry tons of mine ore produced was $1,231,482.59 and the average metal content of this tonnage was 0.116 ounce gold and 11.69 ounces silver, per ton, while the average value was $15.44 per ton. The average metal content was lower by 0.019 ounce gold and by 1.89 ounces silver per ton and the average value was lower by $0.97 per ton than that of the ore produced in the preceding period. The total metal recovery from Belmont mine ores was 8,630.383 ounces gold and 848,446.93 ounces silver, or less than the recovery of the previous year by 2,344.056 ounces gold and 228,497.09 ounces silver. * * *

The only new construction of importance was the installation of an underground electric haulage system on the tenth level. This work comprised the grading and relaying of some 3,600 feet of track; the installation of three and a half ton storage battery locomotive; a motor generator set for charging the batteries, etc. The cost of the installation was $17,558.57 and the haulage system has proved entirely satisfactory as to operation and as to reduced costs as compared with the superseded mule haulage. * * *

The indicated ore reserves of the Belmont mine, as of January 1, 1920, consist of 112,133 tons of positive ore.

As of January 1, 1919, the positive ore reserves were estimated at 82,798 tons of crude ore. During the year 91,857 wet tons, or about 88,348 tons dry crude ore were mined, so that the ore reserves of the beginning of the year have been added to by 117,683 tons.

The probable and possible ores are not estimated, although further development will doubtless prove up these ores in large tonnages.

The Tonopah Mining Co.'s property[26] produced 41,298 tons of ore averaging $18.74 in gold and silver. After all charges were deducted, including the total mining costs of $6.37 a ton, a profit of $6.10 a ton remained. The milling charge and the quantities of gold and silver recovered are not given in the report of the company for 1919. The total value of the mill products, probably bullion, shipped to the smelter amounted to $34,499.51, and the sum paid for the contents of the milling ore treated at the Belmont custom mill was $582,307.36. Dividends paid in 1919 aggregated $300,000, part of which may have been derived from mining operations on holdings outside the State of Nevada. From the company's report the following is taken:

Development work has been curtailed through the year, first by a shortage of labor caused by the failure of men who had responded to war demands to return to camp and later by the labor strike.

A total of 3,804 feet of work was done, divided as follows: Mizpah shaft, 1,504 feet; Silver Top, 810 feet; and Sand Grass, 1,490 feet. Raises in the Mizpah footwall vein from the 500 level west of the Mizpah shaft resulted in finding a considerable tonnage of mill ore between the 400 and 500 levels for a lineal distance of several hundred feet. * * *

[26] Tonopah Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

The company's mill at Millers was closed during the year and the contract with the Tonopah Belmont Development Co. for the treatment of the company's ore expired October 31, 1919, and was not renewed, although the Belmont mill continued to treat the ores until the end of the year. Plans have been formed and put into execution for renewing operations at the company's mill. In addition to the company's ore, it is intended to treat such custom ores as the company may be able to procure for treatment. The mill will be ready to start operating early in the new year.

The West End mine[27] produced 33,140 tons of dry ore, which was treated by cyanidation at its milling plant and contained 6,114.61 fine ounces of gold and 580,445 fine ounces of silver, valued in all at $780,786.49. The total mining cost per ton of ore was $5.07; milling, $3.93; marketing bullion, 34 cents; all of which, added to the cost of ore transportation, depreciation, etc., amounted to $13.60, leaving a profit on West End ore of $9.94 a ton.

At the Tonopah Extension property[28] 70,611 tons of ore was mined and treated, containing 858,411.53 ounces of silver and 8,130.33 ounces of gold, or an average of 12.157 ounces of silver and 0.116 ounce of gold per ton. Bullion was recovered by cyanidation from this ore containing 788,245.55 ounces of silver, which sold for an average of $1.1744 an ounce, amounting to $925,732.49, and 7,614.85 ounces of gold, at $20.6718 an ounce, or $157,412.55, valued in all at $1,083,145.04. Mining costs per ton, including all development work, amounted to $5.512; milling, $3.964; marketing, including refining of bullion, $0.235; and tailing loss, $1.336; total, $11.047. As the gross value of the ore was $16.676 a ton this left a profit of $5.629 a ton. The consumption of 100 per cent sodium cyanide per ounce of bullion recovered was 0.1363 pound, and the consumption of zinc per ounce of bullion recovered was 0.057 pound. The average fineness of the bullion shipped was 945.9 in silver and 9.14 in gold. Development work and production was carried on principally from the Victor shaft, although some work was done from the No. 2 and McKane shafts. From the company report the following is taken:

The southwest crosscut on the 1,540-foot level (Victor shaft), being run for the purpose of finding the Murray vein beyond the west fault, was temporarily discontinued on account of meeting with a flow of water, which flow might be increased considerably if work progressed, thereby interfering materially with stoping operations below this level. Work is now in progress for the installation of a pipe line to conduct this water to the sump on the 1,680-foot level, from which level the water will be pumped to the surface. Eventually this crosscut will connect with the McKane shaft, from which exploration work will be prosecuted. * * *

The Murray vein stopes from the 1,680-foot level were the principal producers of ore during the year. The various footwall and hanging wall branches of this vein were further prospected with very good results, and the chances are good for development of more ore in this part of the mine. * * *

Preparations have been made to sink the Victor shaft 150 feet deeper and establish a level at the 1,880-foot point. Due to the shortage of miners this work was not undertaken.

The McKane shaft is about 1,120 feet deep and situated 1,600 feet west of your No. 2 shaft. It was decided to reopen this shaft and sink it to a depth to correspond with the 1,540-foot level of the Victor workings; after this had been done to connect same with this level and prosecute exploration work westward. To date this shaft has been retimbered to a depth of 580 feet.

The condition of the mine in regard to available ore supply remains satisfactory, although development work has been greatly curtailed by labor shortage and labor difficulties.

As in the past years no definite figures as to tonnage can be given as the nature of the ore bodies renders this impossible.

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[27] West End Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1919.
[28] Tonopah Extension Mining Co. Ann. Rept. for year ending Mar. 31, 1920.

Much labor trouble has been experienced by your company during the past year, and on account of the issues involved being more political than economic were impossible of solution. * * *

At the No. 2 shaft on the 600-foot level, a small amount of ore was stoped from a small vein in the Trachyte formation. This vein is known as the vertical vein and was discovered years ago in workings from No. 1 shaft. It is quite probable that considerable more ore may be developed in this vein.

On the 660-foot level a faulted block of the lower contact vein was developed and produced about 3,000 tons of ore. This level is almost worked out.

Work on the 950, 1,260, and 1,350 foot levels consisted mostly of removing pillars of ore in the Murray, Merger, and O. K. veins. The small amount of development work done resulted in the discovery of a number of small ore shoots.

As in the year previous the greatest tonnage of ore came from the 1,440-foot level. Several large pillars of ore remain to be mined from this level.

Development work will be continued from workings connected with this shaft and the present small production can be continued for another year at least.

The Jim Butler property [29] operated in 1919 on a reduced scale and produced ore of milling grade treated at the Tonopah Belmont plant. From 5,711 tons of ore mined, 1,139.91 ounces of gold and 101,570.49 ounces of silver were recovered, valued at $134,119.02. The company's printed report says:

The entire tonnage was shipped to the Tonopah Belmont Development Co., at the very reasonable treatment charge, including deductions, of $5.52 per ton. Deductions by ore purchasers were $10,750.73, or $1.88 per ton (8 per cent), the values realized being $123,368.29, or $21.60 per ton. Treatment charges amounted to $20,776.86, or $3.64 per ton. Direct mining costs were $53,309.35, or $9.33 per ton, of which $6.65 per ton was for stoping and $2.68 per ton was for development. Transportation costs were $3,616.45, or $0.63 per ton. General expense, including administration, office, insurance, etc., costs were $6,795.56, or $1.19 per ton, and taxes, including bullion taxes, were $1,654.50, or $0.29 per ton. * * *

Of the total ore production, the Wandering Boy vein supplied 3,143 tons; the Fraction vein 1,093 tons; the West End-McNamara vein 409 tons; and miscellaneous veins 27 tons. The gross metal content of the 3,982 tons of Wandering Boy ore was 834.297 ounces of gold and 71,584.71 ounces of silver, and the gross value was $93,546.27. The average value was 0.210 ounce of gold and 17.98 ounces of silver, or $23.49 per ton. The Desert Queen mine produced 1,772 wet tons of crude ore (from the South vein), from which there was culled out 176 tons (9.93 per cent) of waste. The remaining 1,532 dry tons (1,596 wet tons with 4.01 per cent moisture) plus 197 dry tons from ore stocks, had a gross metal content of 305.615 ounces of gold and 29,985.78 ounces of silver; a gross value of $40,572.75 and an average metal content of 0.177 ounce of gold and 17.342 ounces of silver, and an average value of $23.466 per ton. The ground leased from the Tonopah Mining Co. was not worked and the lease was not renewed. The sorting of Desert Queen dumps produced only 33 wet tons of ore, which was shipped with the mine ores with no attempt at segregation.

During the year 167 feet of drifts, 493 feet of crosscuts, and 499 feet of raises, an aggregate of 1,159 lineal feet, was driven in the Wandering Boy mine. No development of importance was performed in the Desert Queen mine. The costs of the development work per foot were $14.699, $14.856, and $13.905 for drifts, crosscuts, and raises, respectively, the average of all headings being $14.437 per foot.

Mining and development costs per ton were greatly higher than in the previous year, the higher costs having been chiefly due to the small bodies of ore worked and to the small tonnage mined.

Tybo district.—The Tybo mine, about 60 miles northeast of Tonopah, was preparing for operation under the management of the Louisiana Consolidated Mining Co. It is reported that a milling plant with flotation unit and a lead smelting plant have been completed, and the mine unwatered. In addition to property in this district, the company owns the Tip Top mine at Mount Montgomery, Nev., which is equipped with a 10-stamp 50-ton mill.

[29] Jim Butler Tonopah Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

Washington district.—Silver ore was shipped to the smelter from the Warner mine, which was operated 166 days.

ORMSBY COUNTY.

Two deep-mine producers reported 104 tons of ore, which was 263 tons less than was produced from three mines in 1918. The total average value per ton increased from $10.93 in 1918 to $21.93 in 1919, and the gold and silver value from $10.68 to $21.93. All the ore was of smelting grade.

Voltaire district.—The Panama Canal property produced silver ore, which was shipped to the smelter.

PERSHING COUNTY.

The new county of Pershing, which was formerly part of Humboldt County, was created in 1919. The output from 40 producers in the territory covered by the new county is shown in the table on page 383.

Two placer producers reported $945 in gold and 9 ounces of silver. At gold and silver mills 109,989 tons of ore was treated and yielded 6,384.83 ounces of gold and 625,258 ounces of silver. At concentration mills 2,394 tons of ore was treated, which yielded 300 tons of gold and silver concentrate, and 2,485 tons of ore was shipped directly to the smelters which contained 418.24 ounces of gold, 40,664 ounces of silver, 185,067 pounds of copper, and 21,098 pounds of lead, valued in all at $89,730, or an average of $36.11 a ton. There was also 498 tons of old tailings shipped, from which silver, gold, and a little copper were recovered.

Antelope district.—The Majuba Hills property was under lease to the Mason Valley Mines Co., which shipped some copper ore containing silver to the smelter at Thompson. Later in the year operations were discontinued. Some lead ore containing silver was shipped from the Last Chance property to a smelter in Utah.

Arabia (Trinity) district.—Some very good lead-silver ore, containing antimony, was shipped from the Montezuma mine. This old property was cleaned out and development work started. Shipments began in September.

Imlay or Humboldt district.—Copper ore, containing some silver and gold, was shipped to the smelter from the Golden Spike property.

Kennedy district.—Silver ore produced from the Independence Day property was shipped to the smelter, and a small quantity of silver ore was produced from the Fourth of July property.

Muddleberry district.—The Old Tiger mine produced a little silver concentrate. This property was equipped with a Gibson mill, which toward the end of 1919 was moved to Rocky Canyon, in the Humboldt Range, east of Rye Patch.

Rochester district.—Fourteen producers reported the output of 103,662 tons of ore, all of which, except 1,460 tons containing gold and silver shipped to the smelter, was milled at cyanidation plants. The total output of the district, including a little placer output, was $117,899 in gold, 667,161 ounces of silver, and a little copper, valued in all at $865,297. The largest producer of silver ore was the Rochester Nevada Silver Mining Co., successor to the Rochester

Mines Co. Considerable silver ore was also mined and milled from the Nevada Packard property which, later in the year, was reported to have been placed in the hands of a receiver. Some silver bullion was recovered from ores treated from the Rochester Combined Mines. The Buck & Charley mine was operated by a lessee, who produced some silver ore of shipping grade. The Lincoln Hill property was developed, and some gold bullion was recovered in a small mill that was operated the greater part of the year.

Rosebud district.—The Dreamland, Abe Lincoln, and Grubstake properties were the only producers in the Rosebud district, and a small quantity of silver ore was shipped from each of them.

Seven Troughs district.—Eight producers reported the output of 8,244 tons of ore, all of which, except 14 tons containing gold and silver shipped to the smelter, was milled and produced gold and silver bullion and some gold and silver concentrate. From the total output there was recovered $28,756 in gold and 1,638 ounces of silver, valued in all at $30,591. Most of this output was from the operations of lessees on various properties, the Seven Troughs Coalition being the largest producer.

Sierra (Sunshine and Dun Glen) district.—The Sheba mine, near Dun Glen, produced some silver ore containing a little lead and gold and shipped some concentrate containing the same metals to the smelter. The 5-stamp mill and concentrator on the property was destroyed by fire on March 2, 1920. The Gem Five mines, at Sunshine, yielded silver ore of shipping grade. The property is opened by a 100-foot shaft.

Unionville or Buena Vista district.—The Arizona mine [30] was under development in 1919, and some ore was milled in the new concentration plant erected on the property. The mill has a daily capacity of 35 tons and since March, 1919, has had a flotation unit in operation, which yielded concentrate containing principally silver. At the property of the Unionville Mining Co. a Gibson mill was operated experimentally, treating the ore taken out in development work during 1919. In Echo Canyon the Rye Patch property produced a small quantity of ore, containing principally silver and a little gold, taken out during development work in 1919. Several smaller lots of silver ore were produced by other properties in the district.

STOREY COUNTY.

Mine production in Storey County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	29	95,051	$518,154	321,636	.....	.....	$839,790
1919	21	50,376	355,640	395,784	223	2,958	799,116
Increase or decrease, 1919	−8	−44,675	−162,514	+74,148	+223	+2,958	−40,674

[30] Ransome, F. L., Mining districts in Humboldt County, Nev.: U. S. Geol. Survey Bull. 414, p. 38, 1909.

The entire output shown in this table and the table on page 383 came from the Comstock district, where there was a decrease in gold but an increase in silver.

Comstock district.—Twenty-one producers in 1919 reported 50,376 tons of ore and old tailings, most of which was treated in gold and silver mills, and produced 16,899.92 ounces of gold and 386,560 ounces of silver, and 58 tons of concentrate, containing some lead, silver, and gold. Only 50 tons of ore, containing gold and silver, was was shipped directly to the smelter. The total output of the district contained $355,640 in gold, 395,784 ounces of silver, 2,958 pounds of lead, and a little copper, valued in all at $799,116. In 1918 there were 29 producers with an output of 95,051 tons of ore valued at $839,790. The principal producers in 1919 were the Consolidated Virginia, Chollar and Potosi, Ophir Silver, Silver Hill, West End, and Union Consolidated mines.

WASHOE COUNTY.

Eleven producers in Washoe County reported 237 tons of ore in 1919, 1,854 tons less than in 1918. The total average value per ton increased from $23.27 in 1918 to $44.78 in 1919, and the gold and silver value in the ore from $17.75 to $42.66. At gold and silver mills 162 tons of ore treated produced gold and silver bullion containing $5,328 in gold and 106 ounces of silver.

Peavine district.—Silver ore, containing copper and a little gold, was shipped from the Peavine property, operated by the Standard Metals Co., which was reported as doing considerable development work in 1919.

White Horse district.—Nine mine operators produced 185 tons of ore, containing gold and silver, valued at $7,096. The principal producers were the Springfield, Nevada, Keystone, and Monitor properties, and most of the ore was treated by amalgamation in a small custom mill.

WHITE PINE COUNTY.

Mine production in White Pine County, Nev., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	48	4,534,662	$686,856	189,210	92,538,218	4,573,941	652,885	$24,117,169
1919	29	2,277,428	[a] 325,995	[a] 134,047	47,912,943	1,342,061	2,952,279	9,674,580
Increase or decrease, 1919	−19	−2,257,234	−360,861	−55,163	−44,625,275	−3,231,880	+2,299,394	−14,442,589

[a] Includes placer production.

The ore produced in White Pine County in 1919—most of it by two operators—amounted to 2,277,428 tons. (See also table, page 383.) The bulk of the ore (2,233,108 tons) was treated and yielded 267,951 tons of concentrates, nearly all of which (267,918 tons) was copper concentrate. The total average value of all concentrates was $32.11

a ton. The ore directly smelted amounted to 44,320 tons, which contained $15,889 in gold, 83,313 ounces of silver, 3,637,874 pounds of copper, 1,318,665 pounds of lead, and 2,952,279 pounds of zinc, valued in all at $1,071,249, or an average of $24.17 a ton. A small quantity of bullion was reported by one placer operator in 1919.

Aurum or Silver Canyon district.—The most active operations in the Aurum district were carried on at the Siegel property, which, during development work, produced some silver ore of shipping grade, containing lead and a little copper. A small shipment of copper-lead ore was made from the Grand Deposit property.

Cherry Creek district.—Nine producers reported the output of 690 tons of ore, containing $835 in gold, 19,857 ounces of silver, 4,333 pounds of copper, and 40,784 pounds of lead, valued in all at $26,043. Silver ore, containing some gold, was shipped from the Exchequer Silver property, which was the largest producer, followed by the Black Metal, Mary Ann, Teacup & Biscuit, and Champion properties.

Duck Creek district.—The Lead Queen claim yielded a few tons of lead ore, which was shipped to a smelter in Utah.

Osceola district.—The results from placer mining and some ore shipped by one producer amounted to $523.

Robinson district [31] *(Ely).*—Most of the output of the Robinson district came from two properties, the Nevada Consolidated and the Consolidated Coppermines. The following table gives a comparison of the production for the last two years and the total output beginning with the year 1904:

Mine production in Robinson district, White Pine County, Nev., 1904–1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	21	4,520,936	$683,823	104,615	92,419,990	479,139	652,885	$23,709,607
1919	8	2,273,961	323,143	56,129	47,871,048	137,768	2,952,279	9,512,841
Increase or decrease, 1919	−13	−2,246,975	−360,680	−48,486	−44,548,942	−341,371	+2,299,394	−14,196,766
Total, 1904–1919	.....	3,4996,714	5,659,083	1,007,169	785,231,342	2,622,241	3,647,815	153,252,113

The Nevada Consolidated mine [32] produced from the Ruth underground area 714,312 tons of ore, averaging 2.04 per cent of copper, and from the Eureka steam-shovel area 1,421,113 tons of ore, averaging 1.377 per cent of copper. The total quantity of ore mined and shipped to the concentrator was 2,135,425 tons, averaging 1.599 per cent of copper. In addition 26,912 tons of carbonate ore was mined, averaging 3.64 per cent of copper, of which 22,730 tons was smelted, leaving 169,421 tons of carbonate ore mined and in stock file inventory at the end of the year. A total of 80,056 tons of concentrating ore was also mined and treated for account of the Consolidated Coppermines

[31] For a description of the geology see Spencer, A. C., The geology and ore deposits of Ely, Nev.: U. S. Geol. Survey Prof. Paper 96, 1917.

[32] Nevada Consolidated Copper Co. Thirteenth Ann. Rept., for year ending Dec. 31, 1919.

Co. from its Ora claim, adjoining the Nevada Consolidated open pit. The annual printed report of the company continues as follows:

The net production of copper for the year was 43,971,892 pounds, as compared with 76,607,062 pounds produced in 1918, and an average annual production of 86,387,900 pounds for the two preceding years. The decrease of production to practically 50 per cent of normal was due entirely to deliberate curtailment in accordance with the policy of limiting output to market demand adopted at the beginning of the year. This policy threw the burden of the usual overhead expenses upon half tonnage, thus increasing the unit cost of production slightly, but it has served to protect the interests of stockholders through conservation of ore reserves and maintenance of a strong financial status.

The total of company and custom ore concentrated during the year was 2,215,481 tons, an average of about 6,000 tons per day, as compared with an average of 11,650 tons per day milled in 1918. Of the company ore milled during the year, 67 per cent was mined from the shovel-pit area and 33 per cent from the underground workings of the Ruth mine.

The concentration of 6,000 tons of ore daily was maintained as the average for the year of 12 months, although the mill was operated for only 11 months and the smelter for approximately 10 months during the year. Operations were completely suspended during the month of August due to a wage controversy with employees resultant upon their refusal to accept the maximum rates that could be legitimately sustained under existing conditions of production and metal market. The major consideration entering into the adjustment of this disagreement was based upon an understanding between employees and management that the company would extend and redouble its efforts toward providing employees with living necessities at lower cost through purchase in large quantities and distribution without profit. To this end additional commissaries were established and existing ones enlarged. These are operated as a part of the regular industrial supply department in such a way that employees enjoy the full benefit of the company's supply organization and its ability to purchase major essentials economically at wholesale prices. * * *

The operating cost of producing refined copper, including depreciation of plant and equipment and the customary charges for fixed and general expenses and for all taxes other than Federal income and profits taxes, for which no reserves were set up, was 18.65 cents per pound. After crediting the ordinary miscellaneous earnings for the year the net cost was 16.14 cents per pound. The per pound cost for the year 1918, including apportionment of reserves for Federal taxes and taking credit for gold and silver and miscellaneous earnings, the cost in 1918 was 15.69 cents per pound, this figure being directly comparable, as to basis of calculation, with that last above stated as the cost for 1919, the computation of costs for both years including the usual credits for precious metal values and for all regular items of miscellaneous income. For the year 1919 the total of such credits amounted to 2.51 cents per pound of copper as compared with 2.24 cents in 1918. A part of the high costs for the year is attributable to half-capacity output, and the costs and loss due to the enforced suspension in August and September were important factors of it, but the major portion is due to continuance of high wage scales and the prevailing excessive cost of fuel and of all supplies and materials required in operations. * * *

The direct operating profits for the year amounted to $1,110,407.13. This corresponds to a net return of 2.526 cents per pound of copper produced, computed upon an average basing price of 18.666 cents per pound, as against 16.14 cents per pound, the cost of production. The price at which earnings for the year 1918 were computed was 21.049 cents per pound, with a production cost of 16.60 cents, including Federal taxes, resulting in a net profit of 4.45 cents per pound of copper produced. The average price realized for all copper sold for the year 1919, including a small tonnage actually sold but not delivered at the close of the year, was 18.853 cents per pound, with average monthly sales prices ranging from 22.3 cents, high, for January, down to 15.39 cents, low, for the month of May, 1919. All unsold copper on hand is carried at the customary price of 13.5 cents per pound.

The total production for 1919 was sold during the year, plus a small tonnage of the stock of unsold metal in inventories at the close of 1918. The policy of curtailment has therefore made it possible to reduce, though by only a small quantity, an accumulation of refined copper which the market was not ready to absorb in the preceding year. * * *

The quarterly distributions to stockholders during the year aggregated $2,999,185.50, being at the rate of $1.50 per share of stock outstanding. The disbursement of this amount reduced the surplus from operations by $1,773,828.23, leaving a balance in the surplus account at December 31, 1919, of $8,160,533.02. * * * As a matter

of interest it may be mentioned that the year's distribution to stockholders brings the total of such distributions from the beginning of operations to the close of the year 1919 to $45,269,023.85. * * *

All prospect drilling having been discontinued, no new tonnages of ore were developed during the year, although there are possibilities that additional tonnages will be brought in with the resumption of drilling westerly and southwesterly of the present shovel pit ore boundary. Deeper drilling in places where some of the churn drill holes have been discontinued before the ore sections were completely pierced should also add to the ore reserves. * * *

Steam shovel mining costs of concentrating ores for the year, exclusive of all taxes, Federal, State, and local, but including depreciation and all other overhead expenses, were 31.59 cents per dry ton of ore. With the usual charge of 40 cents per ton of ore to cover prepaid stripping expense, the total operating cost for 1919 was 71.59 cents per dry ton of ore, as compared with 62.27 cents per ton for 1918 computed on the same basis, an increased cost of 9.32 cents per dry ton of ore.

Capping removal costs for the year 1919 were 38.65 cents per cubic yard, as against 41.20 cents per cubic yard for the year and 34.48 cents per cubic yard for the entire period of operations.

Underground mining costs at the Ruth mine for the year were 99.96 cents per ton, exclusive of taxes, but including all other expense items as described in the paragraph on shovel mining costs, as compared with 98.08 cents per ton for 1918 computed in the same way. These last-stated costs do not include the deferred equipment and development charges of 35 cents per ton, which, being added, bring the 1919 costs to $1.35 per ton, as compared with $1.33 per ton for 1918.

The property of the Consolidated Coppermines Co.[33] yielded 115,662 tons of ore, containing 3,897,934 pounds of copper, 890.04 ounces of gold, 4,573.19 ounces of silver, 3,473,269 pounds of zinc, 53,643 pounds of lead, and 27,071 pounds of manganese. The zinc and manganese were paid for in ore shipments made by lessees who also mined and shipped copper ore. The largest part (80,013 tons) of the company's output of copper ore containing gold and silver, was produced from the Ora mine. The Morris-Brooks mine produced 17,552 tons of copper ore and the Alpha mine 13,573 tons. The following paragraphs are taken from the company's annual printed report:

The further development of the Alpha mine has been attended with very gratifying results. Previous to the period covered by this report, no development had been done below the 1,200 level, with the exception of a very limited footage on the 1,300 and 1,400 levels. During said period a great deal of lateral work has been done on the 1,000, 1,100, 1,200 and 1,300 levels, which work has disclosed some new ore shoots and a considerable extension of ore previously encountered. On the 1,400 level the only work done was to extend the crosscut 80 feet, which penetrated the ore zone and shows in the face oxidized ore assaying 9 per cent copper. Exploration work below this level has been carried on by means of diamond drilling, the results of which have been extremely encouraging since every hole completed in the altered zone encountered commercial ore. Two of these holes showed ore to a depth of over 1,550 feet below the collar of the shaft. At this depth one of them passed through 33 feet of 8.09 per cent ore and the other 350 feet further east passed through 65 feet of 6.85 per cent ore This drilling work is still in progress and is now directed to proving up the position and character of the ore at still greater depths. Meanwhile the Alpha No. 2 shaft, which is the main hoisting shaft of the mine, was during the year sunk an additional 400 feet from which lateral work at deeper levels can be started as soon as desired.

The Alpha ore occurs as replacement in altered limestone near the limestone-porphyry contact. In such a formation the ore bodies are as a rule quite variable in size and irregular in shape. A large amount of development is therefore necessary for thorough exploration of all portions of the ore zone, most of which can be more economically done if deferred until it is desired to mine the ore. The ore bodies in the Alpha mine have therefore not been fully silled out, but in the work that has been done the mine has responded remarkably well to development. Since work in the Alpha was resumed in 1917, there has been mined a total of 89,924 tons of ore averaging 7.72 per cent copper. This tonnage produced 13,205,318 pounds of copper metal. The devel-

[33] Consolidated Coppermines Co. Ann. Rept. for period ending Apr. 20, 1920.

opment work and diamond drilling done to date indicate a tonnage of 500,000 tons of ore averaging 7 per cent copper within the limits of such development. * * *

The old shaft at the Pilot Knob was cleaned out to its original depth of 250 feet and a limited footage of new exploration work was done at this level. There is on this claim a massive outcrop of oxidized iron carrying small copper values. The development work done demonstrated the downward continuation of this iron mass, showing on the bottom level as a limonite very similar to the masses of limonite in the Alpha mine and similarly carrying small copper values. Although no commercial ore was developed there are promising indications that ore will be found when the work is extended to deeper levels.

The Taylor mine was also cleaned out to the 250-foot level and considerable lateral work has been done on this and the 150-foot level. A body of 5 per cent chalcopyrite was found carrying better than the average gold and silver values of the ores of the district. * * *

Sales of copper in 1919 amounted to 3,811,959 pounds, which sold at an average price of 16.9917 cents per pound.

Unsold copper on hand December 31, 1919, amounted to 6,103,001 pounds, and on April 30, 1920, amounted to 1,772,810 pounds.

Ward (Taylor) district.—Lead ore containing silver was shipped from the Nevada United Mines property to the smelter. During the year 1,200 feet of drifts were run on this property. The Argus property was equipped with a cyanide mill to treat ore taken from the dump and the mine. The dump, which represents waste from material mined many years ago, contains about 20,000 tons of ore averaging $13 a ton in silver.

White Pine district.—Six producers reported an output of 563 tons of ore, 445 tons of which was of shipping grade and contained 16.99 ounces of gold, 15,980 ounces of silver, 16,102 pounds of copper, and 446,085 pounds of lead. The remainder, 118 tons of lead ore containing some copper and a little silver, was concentrated. The Grand Prize group was the principal producer of smelting ore and was followed in order by the Nevada, Jennie A., Young Treasure, and Fay properties.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN UTAH.[1]

(MINES REPORT.)

By V. C. Heikes.

PRODUCTION.

GENERAL STATEMENT.

The total output of ores of gold, silver, copper, lead, and zinc from mines in Utah was 54 per cent less in 1919 than in 1918, as shown in the table below. This great decrease was mainly in the output of low-grade disseminated copper ore, which was 6,896,493 tons less than in 1918. The total value of the metal content of the ore decreased somewhat less (48 per cent), owing to an increase in the average value of the ore per ton from $5.85 in 1918 to $6.70 in 1919. The average value of the gold and silver content increased from $1.12 to $2.25 a ton. The total output and value of each metal, however, decreased. There were 179 lode producers, as against 248 lode producers in 1918. No placer production was reported in 1919.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1918–19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	251	14,705,718	[a]$2,949,170	[a]13,455,597	227,169,630	167,008,224	18,399,417	$86,047,597
1919	179	6,745,423	2,159,471	11,649,961	124,061,807	123,829,051	4,431,024	45,169,328
Decrease in 1919	72	7,960,295	789,699	1,805,636	103,107,823	43,179,173	13,968,393	40,878,269
1864–1919	.....	.....	98,227,974	391,126,085	2,313,393,850	4,266,437,432	214,788,050	[b]1,047,372,262

[a] Includes small placer production.
[b] The total, by years, to the end of 1913 appears in Mineral Resources, 1913, pt. 1, p. 366, 1914.

The dividends paid by 11 producers in 1919 amounted to $11,944,766, which, added to the total paid to stockholders since mining became profitable, gives a total of $209,969,133.

The geology of the mining districts and their production from the beginning of mining in Utah to the end of 1917 have been given in a report [2] by B. S. Butler, G. F. Loughlin, F. C. Calkins, and others.

The output of dry and siliceous ore increased from 227,356 tons in 1918 to 239,688 tons in 1919. This classification includes 553 tons of siliceous gold ores, averaging $57.15 in gold, 6.92 ounces of silver,

[1] Valuable assistance in the preparation of this report and in the compilation of the statistical tables was rendered by B. N. Patchell, of the United States Geological Survey.
[2] The ore deposits of Utah, U. S. Geol. Survey Prof. Paper 111, 1920.

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and 15.41 pounds of copper per ton. Gold and silver mixed dry or siliceous ore was produced from only two properties. The siliceous silver ores mined in 1919 by 47 producers amounted to 224,517 tons and averaged per ton $1.86 in gold, 15.82 ounces of silver, 13.24 pounds of copper, and 5.41 pounds of lead, against the output of 36 operators in 1918 producing 227,129 tons, which averaged $2.03 in gold, 17.54 ounces of silver, 14.04 pounds of copper, and 5.34 pounds of lead. The Chief Consolidated mine, in the Tintic district, was the heaviest producer of silver ore, followed by the Dragon, at Silver City, the Brooklyn-Dalton & Lark group, at Bingham; and the Centennial-Eureka and Grand Central mines, in the Tintic district. The Ontario mine, at Park City, was next in importance as a shipper of silver ore. The chloridizing roasting process was used only at Silver City, in the Tintic district, in 1919, where 69,137 tons of siliceous silver ores were directly treated and yielded a base bullion of copper, silver, and gold. Arrangements are being made to treat this bullion by an electrolytic process instead of shipping it to eastern refineries.

The copper ore mined by 37 producers amounted to 5,884,118 tons, which contained 14 cents in gold and 0.10 ounce of silver a ton and 0.99 per cent of copper and had an average value of $3.93 a ton. Comparison with ore of similar character in 1918 shows that the quantity decreased 7,628,156 tons, the gold content was more, the silver content was slightly less, and that the copper content decreased 100,940,700 pounds. Of the copper ore mined the larger part, or 5,685,980 tons, came from the low-grade disseminated deposits. This ore and some old tailings re-treated produced 283,651 tons of copper concentrates, which were smelted. There was 146,861 tons of copper ore smelted directly, of which 141,500 tons was sulphide ore, assaying $1.35 in gold and 1.96 ounces of silver per ton and 2.56 per cent of copper and valued in all at $13.06 a ton; and 5,361 tons was oxidized ore, assaying $1.38 in gold and 4.47 ounces of silver per ton and 5.84 per cent of copper, valued in all at $28.13 a ton.

Lead ore mined by 115 producers decreased from 527,759 tons in 1918 to 435,541 tons in 1919. The ore averaged 83 cents in gold and 15.30 ounces of silver per ton, 0.48 per cent of copper, and 11.01 per cent of lead, and $31.41 in total value per ton. Of this output, 302,258 tons of sulphide and oxidized ores, most of it sulphide, were shipped directly to the smelters, the total quantity averaging $1.10 in gold and 19.96 ounces of silver per ton, 0.60 per cent of copper and 13.85 per cent of lead, and $40.36 in value per ton. Of the lead ore, 121,719 tons was concentrated and yielded 31,912 tons of lead concentrate, averaging $1.44 in gold and 18.59 ounces of silver per ton, 0.85 per cent of copper and 16.99 per cent of lead, and $43.42 in total value per ton. Lead concentrate from 174,904 tons of lead-zinc ore aggregated 59,582 tons, averaging $7.82 in gold and 11.17 ounces of silver per ton, 0.54 per cent of copper, and 21.28 per cent of lead, and $44.88 in total value per ton.

Zinc ore shipped from three properties in 1919 aggregated 976 tons, against 1,849 tons from nine producers in 1918. Most of the zinc ore produced in 1919 was oxidized and of smelting grade and averaged 21.14 per cent of recoverable zinc. The Judge electrolytic zinc plant, near Park City, continued to produce high-grade zinc in 1919. Zinc concentrates saved from lead-zinc ore and tailings milled aggregated

3,330 tons and averaged $1.21 in gold and 1.49 ounces of silver per ton, 0.39 per cent of copper, 1.04 per cent of lead, and 39.45 per cent of recoverable zinc.

Eight lead-zinc producers in 1919 reported 183,176 tons of ore and old tailings re-treated. The ore was milled, making a lead concentrate, a zinc concentrate, and a lead-zinc concentrate. The tailings also yielded some zinc concentrate, lead-zinc concentrate, and lead concentrate. Only 106 tons of crude lead-zinc ore was shipped to the smelter in 1919.

Copper-lead ore, most of it oxidized or carbonates, decreased from 7,495 tons produced by 15 mines in 1918 to 1,924 tons produced by 11 mines in 1919. Of this ore, 1,915 tons was of smelting grade and averaged 34 cents in gold and 20.17 ounces of silver per ton, 3.24 per cent of copper, 19.39 per cent of lead, and $55.51 in value per ton. The remainder of the copper-lead product was sorted slag.

Concentrates of all kinds produced in Utah in 1919, including those heretofore mentioned, aggregated 381,085 tons and contained nearly 52 per cent of the gold, against nearly 53 per cent in 1918; more than 13 per cent of the silver, against more than 17 per cent in 1918; more than 88 per cent of the copper, against nearly 87 per cent in 1918; nearly 30 per cent of the lead, against nearly 38 per cent in 1918; and 88 per cent of the zinc, against nearly 93 per cent in 1918. In 1919 the recoverable metal content of the concentrates was valued at $25,532,733, or a total average value per ton of $67, as against a total value in 1918 of $58,550,544 or a total average value per ton of $72.91.

Crude ore of all kinds shipped directly to the smelters amounted to 607,840 tons or about 9 per cent of the total output, and produced nearly 44 per cent of the gold in 1919, against nearly 46 per cent in 1918; about 81 per cent of the silver, against nearly 79 per cent; more than 11 per cent of the copper, against nearly 12 per cent; more than 69 per cent of the lead, against 61 per cent; and nearly 11 per cent of the zinc, against more than 7 per cent. In 1919 the total value of the crude ore shipped to smelters was $18,671,980, or an average value per ton of $30.72, as against a total value in 1918 of $26,012,964, or an average value per ton of $26.88.

At mills using cyanidation and amalgamation gold and silver were recovered from 14,614 tons of ore, the value of which was $124,310, or an average value per ton of $8.51. In 1918 the recovery of gold and silver from ores given similar treatment was valued at $8,730, or an average value per ton of $8.63.

Ore and metals produced in Utah in 1919.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry or siliceous	50	239,688	$521,274	3,645,909	2,758,479	1,438,014	.....
Copper	37	5,884,118	803,591	586,417	116,312,084	1,231	.....
Lead	115	435,541	362,897	6,664,219	4,157,256	95,881,706	.....
Zinc	3	976	.....	.....	.....	.....	491,926
Copper-lead	11	1,924	673	38,936	125,645	746,640	.....
Lead-zinc	8	183,176	471,036	714,480	708,343	25,761,460	3,939,098
	.....	6,745,423	2,159,471	11,649,961	124,061,807	123,829,051	4,431,024

Ore sold or treated in Utah in 1919, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	47	48,676	32,905	.....	29	458	82,115
Box Elder	37	1,363	503	.....	.....	106	2,009
Juab	150,350	5,502	77,185	151	19	.....	233,207
Millard	4	.....	.....	.....	.....	.....	4
Morgan	.....	.....	59	.....	.....	.....	59
Piute	14,715	.....	1,794	.....	.....	.....	16,509
Salt Lake	23,538	5,826,891	124,697	.....	510	136,136	6,111,772
Summit	15,024	.....	79,255	.....	.....	6,080	100,359
Tooele	13,338	1,409	70,401	825	1,366	.....	87,339
Utah	22,634	.....	41,647	.....	.....	.....	64,281
Wasatch	.....	.....	7,095	.....	.....	40,396	47,491
Washington	1	277	.....	.....	.....	.....	278
	[a]239,688	5,884,118	435,541	976	1,924	183,176	6,745,423
Value per ton in gold and silver.	$19.21	$0.25	$17.97	.....	$23.01	$6.94	$2.25

[a] Includes 553 tons of gold ore, 14,618 tons of gold and silver ore, and 224,517 tons of silver ore.

GOLD.

The mine production of gold in Utah in 1919 was $2,159,471—a decrease of $789,699 compared with 1918. The largest part of the gold was contained in ores produced in Salt Lake County and amounted to $1,399,557, against $2,083,254 in 1918; Juab County ranked next, with $495,153, against $628,593 in 1918; and Piute County mines were credited with $106,819, against $35,979 in 1918. The Bingham district produced $1,389,849 and the Tintic district $535,534; in 1918 these outputs were, respectively, $2,056,005 and $678,952. Ores treated in mills equipped for amalgamation produced $4,224 in gold in 1919 from 43 tons of ore mined in Box Elder, Millard, Piute, and Washington counties. Cyanidation of ore was reported by only one operator in 1919. Concentrates of copper, lead, lead-zinc, and zinc ore contained altogether $1,121,810 in gold, against $1,561,157 in 1918. Copper concentrates contained the largest quantity of gold, or 29,255.43 ounces, against 50,518.31 ounces in 1918; the lead concentrates contained 24,756.81 ounces, against 23,936.54 ounces in 1918; and the zinc concentrates 195 ounces, against 294.87 ounces in 1918. Lead-zinc concentrates in 1919 produced 60.33 ounces of gold, against 697.36 ounces in 1918.

A large part of the gold produced in Utah is a by-product of the copper and lead ores. Ranking first in 1919, the Utah Copper property is credited with 28,907 ounces. The United States property at Bingham reported about 99 per cent of its output of gold as contained in lead ores and concentrate and the remainder in zinc concentrate and copper ores. Next in importance as producers of gold, named in order of production, were the Highland Boy, with 10,507 ounces, the Centennial-Eureka, Deer Trail, and Chief Consolidated mines.

Siliceous gold ore, little of which has been mined in Utah in recent years, was shipped from the Wedge mine, near Marysvale, and by lessees from the Blue Bird workings of the Annie Laurie mine, at Gold Mountain, in Piute County. From the Dragon property, in the Tintic district, 464 tons of oxidized iron ore, containing considerable gold, was shipped to the smelter. The Deer Trail mine produced much gold from siliceous gold and silver ore, which was cyanided.

Mine production of gold in Utah in 1919, in fine ounces.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	4.70	145.10	1,285.85	1.58	10.00	1,447.23
Box Elder	26.60		20.42			47.02
Juab	18,417.35	307.22	5,221.52	6.94		23,953.03
Millard	2.23					2.23
Piute	4,079.37		1,088.00			5,167.37
Salt Lake	1,525.63	38,354.96	5,329.12	9.99	22,483.87	67,703.57
Summit	361.11		2,522.80		13.99	2,897.90
Tooele	166.73	66.43	528.34	14.05		775.55
Utah	631.94		1,373.35			2,005.29
Wasatch			185.74		278.51	464.25
Washington	.97					.97
	[a] 25,216.63	38,873.71	17,555.14	32.56	22,786.37	104,464.41

[a] Includes 1,528.81 ounces from gold ore, 3,489.71 ounces from gold and silver ore, and 20,198.11 ounces from silver ore.

SILVER.

The mine production of silver in Utah in 1919 was 11,649,961 ounces, valued at $13,047,956, a decrease of 1,805,636 ounces in quantity and of $407,641 in value. The largest production was from Juab County, credited with 4,822,227 ounces, against 4,994,806 ounces in 1918. Utah County had the next largest output, 1,993,381 ounces in 1919, against 1,734,489 ounces in 1918. The Bingham district in Salt Lake County produced 1,607,132 ounces, or nearly 14 per cent of the State total; the Tintic district, in Juab and Utah counties, 6,779,829 ounces; and the Park City region, in Summit and Wasatch counties, 1,945,670 ounces. Concentrates produced at milling plants yielded 1,592,613 ounces of silver, against 2,316,766 ounces in 1918. The copper ores milled produced 284,950 ounces in 1919 against 509,298 ounces in 1918. Lead concentrate from low-grade lead ore and lead-zinc ore contained 1,258,528 ounces of silver, or an average per ton of 13.76 ounces, in 1919, against 1,494,122 ounces or an average of 10.46 ounces, in 1918; zinc concentrate contained 1.49 ounces per ton, against 2.12 ounces per ton in 1918; and lead-zinc concentrate contained 19.32 ounces per ton.

The silver content of bullion produced from ores treated by amalgamation was 24 ounces against 365 ounces in 1918 and 26 ounces in 1917. Only one operator reported cyanidation of gold and silver ores in 1919. At Silver City a leaching mill using a chloridizing roast on custom ores recovers a rich silver bullion from which 516,548 ounces was reported in 1919.

Eleven properties each produced more than 500,000 ounces of silver in 1919. The Chief Consolidated, in the Tintic district, ranked first, with an output of 2,757,533 ounces, followed by the Tintic Standard, in the same district; the Silver King Coalition and the Ontario at Park City, the Iron Blossom, in the Tintic district, the United States mines at Bingham, the Judge mine at Park City, the Utah Consolidated at Bingham, the Eagle and Blue Bell mine, in the Tintic district, the Ophir Hill at Ophir, and the Utah Copper at Bingham. The high price of silver stimulated the production of ores containing silver during the last half of the year, when the quoted price ranged from $1.0639 an ounce in July to $1.3197 in December.

Mine production of silver in Utah in 1919, in fine ounces.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	170	3,608	282,803	228	3,300	290,109
Box Elder	6	559	9,522	.....	.....	10,087
Juab	2,615,564	47,349	2,158,594	720	.....	4,822,227
Morgan	.....	.....	223	.....	.....	223
Piute	91,597	.....	39,282	.....	.....	130,879
Salt Lake	100,247	526,115	796,642	9,565	504,437	1,937,006
Summit	318,000	.....	1,211,738	.....	3,850	1,533,588
Tooele	52,058	8,578	431,110	28,423	.....	520,169
Utah	468,265	.....	1,525,116	.....	.....	1,993,381
Wasatch	.....	.....	209,189	.....	202,893	412,082
Washington	2	208	.....	.....	.....	210
	[a] 3,645,909	586,417	6,664,219	38,936	714,480	11,649,961

[a] Includes 3,827 ounces from gold ore, 89,411 ounces from gold and silver ore, and 3,552,671 ounces from silver ore.

COPPER.

Owing to inability to market their product, all Utah copper companies curtailed operations in 1919, production being 124,061,807 pounds of copper, valued at $23,075,496, a decrease of 103,107,823 pounds in quantity and of $33,035,403 in value. The Bingham or West Mountain district, in Salt Lake County, produced 116,696,528 pounds of copper in 1919, against 211,194,861 pounds in 1918; the Tintic district, in Juab County, 3,251,008 pounds, against 6,568,802 pounds; the Park City region, in Summit and Wasatch counties, 760,858 pounds, against 915,649 pounds; Beaver County, 538,585 pounds, against 2,635,564 pounds; and Tooele County, 1,512,157 pounds, against 2,531,769 pounds.

Concentrates of all kinds produced at Utah milling plants contained 109,695,131 pounds of copper, against 196,912,158 pounds in 1918. Copper concentrates contained 108,447,551 pounds, against 194,436,026 pounds in 1918; lead concentrates, 1,181,174 pounds, against 2,048,480 pounds; zinc concentrates, 25,600 pounds, against 36,724 pounds; and lead-zinc concentrates, 40,806 pounds, against 342,898 pounds. Crude ore shipped to smelters contained 13,998,982 pounds of copper, against 27,157,575 pounds in 1918. The crude copper ore smelted contained 7,863,829 pounds, of which 7,237,653 pounds was from sulphide ores and 626,176 pounds from oxidized ores. Lead ores smelted produced 3,615,301 pounds of copper, the sulphide ores yielding 3,019,699 pounds and the oxidized ores 595,602 pounds.

Copper-lead ores, which were mostly oxidized, contained 123,879 pounds of copper. The dry or siliceous ores, used principally for fluxing at smelting plants, contained 2,395,973 pounds, against 2,564,417 pounds in 1918. The low-grade copper-bearing disseminated ores mined and concentrated contained 108,382,949 pounds of copper, against 194,381,368 pounds in 1918. Part of the tailing of the Cactus mill, in Beaver County, was reworked, and the output is included above.

The leading producers of copper, named in order of production, were the Utah Copper Co., reporting[3] 105,088,740 net pounds; the Highland Boy, 5,710,346 net pounds;[4] and the Ohio Copper Co.

[3] Utah Copper Co. Fifteenth Ann. Rept., for year ending Dec. 31, 1919.
[4] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

Mine production of copper in Utah, in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	1,983	515,722	18,053	2,607	220	538,585
Box Elder	.....	207,303	3,303	.....	.....	210,606
Juab	1,898,563	525,695	133,229	3,217	.....	2,560,704
Piute	2,585	.....	19,256	.....	.....	21,841
Salt Lake	520,868	114,810,413	1,663,404	32,898	597,543	117,625,126
Summit	52,643	.....	428,989	.....	1,844	483,476
Tooele	133,177	115,165	1,176,892	86,923	.....	1,512,157
Utah	148,660	.....	545,484	.....	.....	694,144
Wasatch	.....	.....	168,646	.....	108,736	277,382
Washington	.....	137,786	.....	.....	.....	137,786
	[a]2,758,479	116,312,084	4,157,256	125,645	708,343	124,061,807

[a] Includes 8,522 pounds from gold ore, 2,206 pounds from gold and silver ore, and 2,747,751 pounds from silver ore.

LEAD.

On account of the unfavorable lead market, together with the shortage of labor and high operating costs, no effort was made to mine lead deposits that did not carry a relatively high silver content. This resulted in a reduction of the output.

The mine production of lead in Utah in 1919 was 123,829,051 pounds, 43,179,173 pounds less than in 1918. The Bingham or West Mountain district produced 54,610,987 pounds, compared with 79,773,150 pounds in 1918. The greatest part of the production at Bingham came from the United States, Highland Boy, and Utah Apex mines. The Park City region produced 21,311,284 pounds of lead, against 24,320,074 pounds in 1918; the Tintic district produced 24,463,163 pounds, against 30,652,358 pounds; the combined production of the Ophir and Rush Valley districts, in Tooele County, aggregated 11,063,952 pounds, against 12,912,350 pounds; and the output in Beaver County decreased from 6,506,428 pounds in 1918 to 4,897,083 pounds in 1919.

Lead contained in total concentrate recovered at milling plants and shipped to smelters amounted to 36,584,005 pounds, against 63,074,196 pounds in 1918. The lead concentrates from lead and lead-zinc ores averaged 19.78 per cent of lead in 1919, against 20.41 per cent in 1918; zinc concentrates averaged 1.04 per cent of lead in 1919, against 1.81 per cent in 1918.

The total crude ore of shipping grade contained 85,725,924 pounds, against 101,811,651 pounds in 1918. Sulphide lead ore contained 58,287,586 pounds of lead, against 53,868,105 pounds in 1918. The oxidized lead ores carried 25,460,427 pounds, against 45,743,869 pounds in 1918.

No lead was contained in zinc ores shipped in 1919. Of the copper-lead ores the oxidized or carbonate ores contained 655,767 pounds and the sulphide ores 87,030 pounds of lead.

Ranking first in the output of lead in 1919 was the property of the United States Mining Co., at Bingham, followed in order by the Highland Boy and Utah Apex, at Bingham, and the Silver King Coalition, at Park City. Each of these was credited with more than 10,000,000 pounds of lead. Those following were the Ophir Hill Consolidated, Judge, Tintic Standard, Chief Consolidated, Eagle & Blue Bell, and Horn Silver mines.

Mine production of lead in Utah in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Beaver	.....	1,231	4,775,568	4,440	115,844	4,897,083
Box elder	.....	.....	233,225	.....	23,504	256,729
Juab	1,906	.....	17,792,553	5,208	.....	17,799,667
Morgan	.....	.....	24,035	.....	.....	24,035
Piute	224,110	.....	216,281	.....	.....	440,391
Salt Lake	.....	.....	38,917,704	92,043	20,735,783	59,745,530
Summit	.....	.....	14,234,702	.....	83,139	14,317,841
Tooele	638,510	.....	11,027,996	644,949	.....	12,311,455
Utah	573,488	.....	6,469,389	.....	.....	7,042,877
Wasatch	.....	.....	2,190,253	.....	4,803,190	6,993,443
	[a]1,438,014	1,231	95,881,706	746,640	25,761,460	123,829,051

[a] Includes 222,491 pounds from gold and silver ore and 1,215,523 pounds from silver ore.

ZINC.

The Bingham district, the Park City district, and Tooele County, named in order of output, were the chief producers of zinc in 1919. Smaller quantities were produced in Beaver County and in the Promontory district of Box Elder County. The total mine production of recoverable zinc in Utah in 1919 was 4,431,024 pounds, valued at $323,465, against 18,399,417 pounds, valued at $1,674,347, in 1918. The Judge property, at Park City, continued to be a large producer. Salt Lake County, with Bingham as the principal source, produced 2,579,608 pounds of recoverable zinc, against 11,160,521 pounds in 1918. Beaver County decreased its output from 2,518,987 pounds in 1918 to 44,268 pounds in 1919. The Tintic district decreased its output from 264,820 pounds in 1918 to 93,571 pounds in 1919.

Lead-zinc ore and old tailings aggregating 183,176 tons were smelted or milled, of which 106 tons of ore was shipped directly to the smelters and 174,904 tons of ore and 8,166 tons of old tailings were concentrated and yielded 59,582 tons of lead concentrate, 3,330 tons of zinc concentrate, and 2,286 tons of lead-zinc concentrate. The old tailings yielded 545 tons of lead concentrate, 26 tons of zinc concentrate, and 31 tons of lead-zinc concentrate, all of which were included above. The lead-zinc ore and tailings concentrates shipped to smelters contained 3,939,098 pounds of recoverable zinc, of which 35,666 pounds was contained in crude lead-zinc ore, 2,627,440 pounds in zinc concentrate, and 1,275,992 pounds in lead-zinc concentrate. Most of the lead-zinc concentrate came from the Judge mine, at Park City, and the remainder from tailing operations at Midvale.

Nearly all the lead-zinc product was treated at the electrolytic zinc plant at Park City, and some was shipped to manufacturers of zinc oxide in the Eastern States. Crude zinc ores and lead-zinc ores smelted contained 527,592 pounds of zinc, of which 491,926 pounds was derived from zinc ores and 35,666 pounds from lead-zinc ores. In 1919 the oxidized zinc and lead-zinc ore produced 434,021 pounds of recoverable zinc, and 93,571 pounds was produced from sulphide ores.

The leaders in the output of zinc in 1919 were the properties of the United States Mining Co., at Bingham, and the Judge property, near Park City, followed by the Scranton mine, in Tooele County, and the Utah Apex mines, at Bingham.

Mine production of recoverable zinc in Utah in 1919, in pounds.

County.	Zinc ore.	Lead-zinc ore.	Total.
Beaver	.....	44,268	44,268
Box Elder	.....	35,666	35,666
Juab	93,571	.....	93,571
Salt Lake	.....	2,579,608	2,579,608
Summit	.....	16,796	16,796
Tooele	398,355	.....	398,355
Wasatch	.....	1,262,760	1,262,760
	491,926	3,939,098	4,431,024

Zinc ore and concentrates produced from Utah mines and mills sold in 1919.

Classification.	County.	Quantity, dry weight.	Average assay of ore or concentrates.
		Short tons.	*Per cent.*
Sulphide ore	Juab	151	36.45
Mixed carbonate and siliceous ore	Box Elder and Tooele	931	27.56
Concentrates	Beaver, Salt Lake, Summit, and Wasatch	5,616	41.77
		6,698	39.63

UTAH MINING INDUSTRY, 1919.

Conditions were not favorable for mining in 1919, owing to high operating costs and relatively low prices for metals, except silver. Labor was scarce and very inefficient. Small producers were compelled to suspend work, and all the larger companies curtailed production considerably. The smelting companies, also affected by these conditions, were forced to curtail operations. As a whole, the mine output was reduced and much necessary development work was left undone. In many mines operations were limited to one shift, which was sufficient to supply the curtailed demand of smelters.

In March wage reductions were made at a number of mining camps in Utah. The operators in the Tintic district made a general reduction of 75 cents a shift, making the wages then in force $4.50 a day for machine men and $4 a day for muckers. At Bingham a reduction of 75 cents a day was made in February, followed by a further reduction of 25 cents on March 1, and at Park City the wage was reduced 75 cents a shift.

The assessed valuation of mines in Utah under the new State law, which operated for the first time in 1919, was in round numbers $100,000,000, as compared with $46,000,000 for 1918. Metalliferous mines are now taxed on a basis of three times their net proceeds and in addition according to their improvements—including milling plants, whether situated at the property in question or not, such as the Magna and Arthur concentration plants of the Utah Copper Co.—instead of on their net proceeds plus an "occupation" tax, as in 1918.

METALLURGIC INDUSTRY.

GENERAL STATEMENT.

Cyanidation and amalgamation of ores mined in Box Elder, Millard, Piute, and Washington counties was reported by four producers. The output for 1919 from gold and silver mills was derived from 14,614 tons of ore, and consisted of 204.32 fine ounces of gold and 24 ounces of silver recovered by amalgamation and 2,316 ounces of gold and 64,449 ounces of silver recovered by cyanidation. The total value was $124,310.

Of the 26 plants operated in 1919 in Utah, 1 was an amalgamation plant, 1 concentration and cyanidation, and 21 concentration plants. Eight of the concentration plants were equipped with tables followed by the oil-flotation process, and four used flotation alone. Conditions at other plants were about the same as reported in 1918. One plant was equipped for wet concentration followed by magnetic separation. Three leaching plants were active, of which one, near Park City, produced electrolytic zinc, and another, at Silver City, gave the ores a chloridizing roast, recovering the metals on scrap iron. At Magna the Utah Copper Co. suspended operations on January 1, 1919, at its sulphuric-acid leaching plant for treatment of low-grade oxidized copper ore. Intermittent shipments of cement copper precipitates resulting from previous operations were thereafter made.

Mine production of metals from Utah concentrates in 1919.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	13,314	4,069	215.58	60,050	494,307	1,027,966	44,268	$221,367
Juab	7,301	2,088	92.00	123,055	.....	615,722	.....	172,357
Piute	.....	649	1,169.00	24,792	223	222,491	.....	63,765
Salt Lake	5,827,598	340,159	51,739.75	802,646	108,576,543	21,633,535	2,579,608	23,498,646
Summit	51,696	10,719	674.88	211,569	67,627	4,776,663	16,796	517,876
Tooele	45,060	14,229	97.85	167,608	447,695	3,504,438	.....	458,750
Wasatch	40,396	9,172	278.51	202,893	108,736	4,803,190	1,262,760	599,972
	5,985,365	381,085	54,267.57	1,592,613	109,695,131	36,584,005	3,903,432	25,532,733

By kinds of concentrates.

Copper	.....	283,975	29,255.43	284,950	108,447,551	.....	.....	$21,095,151
Lead	.....	91,494	24,756.81	1,258,528	1,181,174	36,198,632	.....	4,059,546
Zinc	.....	3,330	195.00	4,968	25,600	69,470	2,627,440	209,842
Lead-zinc	.....	2,286	60.33	44,167	40,806	315,903	1,275,992	168,194

The smelters near Salt Lake City and Tooele operated at from 40 to 60 per cent of capacity during 1919, and there was no accumulation of ores for the winter stock piles from the heavy summer shipments as heretofore. Repairs and some improvements were made. Wages were reduced by 50 to 75 cents a day in February and in July were put back to the former scale. The smelters did not increase smelting charges in proportion to increased costs.

Mine production of metals from Utah crude ore shipped to smelters in 1919.

By counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Beaver	11,898	837.53	166,208	41,337	2,358,982	.....	$336,181
Box Elder	1,972	20.43	10,081	210,606	256,729	35,666	67,097
Juab	168,317	22,715.38	4,287,944	2,199,873	17,183,945	93,571	6,598,822
Millard	1	.70	.....	.....	.....	.....	15
Morgan	59	.....	223	.....	24,035	.....	1,524
Piute	1,936	1,507.13	41,622	21,618	217,900	.....	93,341
Salt Lake	280,588	15,962.67	1,134,040	9,046,113	38,108,152	.....	5,302,412
Summit	40,898	2,223.01	1,322,019	415,849	9,541,178	.....	2,109,645
Tooele	42,066	674.26	349,683	1,063,084	8,801,873	398,355	1,098,896
Utah	52,733	1,722.39	1,888,061	694,070	7,042,877	.....	2,652,603
Wasatch	7,095	185.77	209,189	168,646	2,190,253	.....	385,583
Washington	277	.....	208	137,786	.....	.....	25,861
	607,840	45,849.27	9,409,278	13,998,982	85,725,924	527,592	18,671,980
By kinds of ore.							
Dry or siliceous	155,724	20,095.31	3,037,218	2,395,973	1,210,379	.....	$4,326,892
Copper	146,861	9,618.27	301,467	7,863,829	1,231	.....	1,999,207
Lead	302,258	16,104.25	6,031,977	3,615,301	83,748,013	.....	12,199,810
Zinc	976	.....	.....	.....	.....	491,926	35,911
Copper-lead	1,915	31.44	38,616	123,879	742,797	.....	106,310
Lead-zinc	106	.....	.....	.....	23,504	35,666	3,850

PRODUCTION BY COUNTIES.

GENERAL FEATURES.

Mine production of gold, silver, copper, lead, and zinc in Utah in 1919.

County.	Gold.		Silver.	
	Quantity.	Value.	Quantity.	Value.
	Fine ounces.		*Fine ounces.*	
Beaver	1,447.23	$29,917	290,109	$324,922
Box Elder	47.02	972	10,087	11,297
Juab	23,953.03	495,153	4,822,227	5,400,894
Millard	2.23	46	.....	.....
Morgan	.....	.....	223	250
Piute	5,167.37	106,819	130,879	146,584
Salt Lake	67,703.57	1,399,557	1,937,006	2,169,447
Summit	2,897.90	59,905	1,533,588	1,717,619
Tooele	775.55	16,032	520,169	582,589
Utah	2,005.29	41,453	1,993,381	2,232,587
Wasatch	464.25	9,597	412,082	461,532
Washington	.97	20	210	235
	104,464.41	2,159,471	11,649,961	13,047,956

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaver	538,585	$100,177	4,897,083	$259,545	44,268	$3,232	$717,793
Box Elder	210,606	39,173	256,729	13,607	35,666	2,604	67,653
Juab	2,560,704	476,291	17,799,667	943,382	93,571	6,831	7,322,551
Millard	.....	.....	.....	.....	.....	.....	46
Morgan	.....	.....	24,035	1,274	.....	.....	1,524
Piute	21,841	4,062	440,391	23,341	.....	.....	280,806
Salt Lake	117,625,126	21,878,273	59,745,530	3,166,513	2,579,608	188,311	28,802,101
Summit	483,476	89,927	14,317,841	758,846	16,796	1,226	2,627,523
Tooele	1,512,157	281,261	12,311,455	652,507	398,355	29,080	1,561,469
Utah	694,144	129,111	7,042,877	373,273	.....	.....	2,776,424
Wasatch	277,382	51,593	6,993,443	370,652	1,262,760	92,181	985,555
Washington	137,786	25,628	.....	.....	.....	.....	25,883
	124,061,807	23,075,496	123,829,051	6,562,940	4,431,024	323,465	45,169,328

Ore sold or treated, number of deep mines producing, and value of ores in Utah in 1918 and 1919.

County.	Ore sold or treated.		Number of deep mines producing.		Average total value per ton.		Average value per ton in gold and silver.	
	1919	Increase or decrease.	1918	1919	1918 [a]	1919	1918 [a]	1919
	Short tons.	*Short tons.*						
Beaver	82,115	— 223,927	40	20	$5.66	$8.74	$1.27	$4.32
Box Elder	2,009	— 6,278	7	5	37.44	33.67	2.82	6.11
Cache	.....	— 28	1	.....	21.18	.....	.61	.....
Garfield	.....	— 5	1	.....	12.20	.....	12.20	.....
Juab	233,207	— 71,208	40	38	29.35	31.40	18.48	25.28
Millard	4	— 45	1	1	20.69	11.50	1.57	11.50
Morgan	59	— 227	1	1	30.11	25.83	4.27	4.24
Piute	16,509	+ 13,466	5	6	42.64	17.01	33.95	15.35
Salt Lake	6,111,772	—7,630,336	71	52	4.74	4.71	.37	.58
Summit	100,359	— 16,438	8	9	29.44	26.18	18.28	17.71
Tooele	87,339	— 14,966	51	30	23.41	17.88	6.99	6.85
Uinta	.....	— 1	1	.....	94.00	.....	2.00	.....
Utah	64,281	— 6,740	15	13	34.35	43.19	25.15	35.38
Wasatch	47,491	— 3,041	3	2	29.31	20.75	10.32	9.92
Washington	278	— 521	3	2	110.86	93.10	.26	.92
	6,745,423	—7,960,295	248	179	5.85	6.70	1.12	2.25

[a] Value per ton, placer product excluded.

BEAVER COUNTY.

Mine production in Beaver County, Utah, 1918–19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	40	306,042	$39,135	350,315	2,635,564	6,506,428	2,518,987	$1,731,618
1919	20	82,115	29,917	290,109	538,585	4,897,083	44,268	717,793
Decrease, 1919.	20	223,927	9,218	60,206	2,096,979	1,609,345	2,474,719	1,013,825
Total, 1860–1919 [a]	.....	.....	836,791	21,801,330	52,812,532	422,807,465	36,070,774	51,841,938

[a] The corresponding table of production by years is given to the end of 1913 in Mineral Resources for 1913, pt. 1, p. 389.

Both the quantity and the value of all the metals in Beaver County decreased in 1919, as shown in the above table.

The 4,069 tons of concentrates shown in the table (p. 426) were derived from 13,314 tons of lead ore and from 48,515 tons of re-treated tailings that yielded copper concentrate. These 4,069 tons, which had an average value of $54.40 a ton, should be compared with 9,700 tons, valued at $85.13 a ton, in 1918. The crude ore shipped (p. 427) was mostly oxidized and averaged $28.25 a ton, compared with 33,726 tons, valued at $20.86 in 1918.

Beaver Lake district.—No production was reported from the mines in the district, but some development of the Beaver Copper and Capitol mines was made.

Lincoln district.—Small shipments of lead ore, which was probably mined during 1918, were made from the Rattler claim and from the Creole property.

Pine Grove district.—The Revenue mine produced some lead ore, containing silver and gold, which was shipped to the smelter.

Rocky district.—A large tonnage of oxidized iron ore was shipped for flux to the Garfield and Midvale smelters from the Montreal property. This ore is said to have contained a small quantity of silver and copper, but no report was made of the total content.

San Francisco district (Frisco and Newhouse).—Six producers reported the output of 81,343 tons of ore and old tailings, containing $29,159 in gold, 278,208 ounces of silver, 513,659 pounds of copper, 4,684,486 pounds of lead, and 44,268 pounds of zinc, valued in all at $687,802, or an average value per ton of $8.45. A little over half the crude ore mined was milled at the Quad Metal and Horn Silver concentrating plants. This ore aggregated 13,314 tons and yielded 4,069 tons of concentrate containing mainly copper and lead. There were 11,126 tons of crude ore shipped directly to the smelters, containing 800.85 ounces of gold, 154,307 ounces of silver, 16,411 pounds of copper, and 2,146,385 pounds of lead. The old tailings treated were largely from the last operations of the Utah Leasing Co. on Cactus mill tailings. Some tailings containing lead were shipped directly to the smelters from the Horn Silver mine.

From the Horn Silver property [5] 21,285 tons of ore was shipped in 1919. The company received from the smelter $149,668.25 for the output, which consisted of 18,968 tons of lead ore, 395 tons of zinc ore, 106 tons of copper ore, and 1,816 tons of lead concentrates. The expense of operations in 1919 was $26,378.26 for development work and $178,117.67 for mill improvements. Parts of the annual printed report of the company follow:

> The general situation at the property has not changed materially during the year, except that our increased costs of labor and supplies have markedly reduced our profits. We have also been obliged to pay an increased smelter charge on our ore. These costs have not been offset by the discovery during the year of any new deposits of ore of substantial value. We still have prospects in the direction of opening up some ore in the old workings. * * *
>
> The 400 south stope turned suddenly into low-grade ore. These rapid changes in ore values are characteristic of the Horn Silver, and make it necessary in its operation to keep ourselves in a position to shift quickly from "day's pay" to leasing to avoid losses.
>
> The recent falling off in our production is due to the fact that the United States Smelting Co. has refused to take any more sulphide tailings shipments, as they are overstocked with low-grade ore. * * *
>
> Our present production is still coming from the upper portions of the mine—from the stopes above the 700—although we are working a stope on the 950 which is producing ore suitable for treatment in the mill, which is now in operation April, 1920). * * *
>
> We also have as an asset, as pointed out in previous reports, the tailings dumps, which only await the perfecting of a process to yield a very substantial sum. We are now in negotiation with the patentees of a process which seems likely to enable us to successfully treat these carbonate ores, which run 6 ounces silver and about 6 per cent lead. At the present prices of these metals we anticipate a substantial profit should the process prove as successful as the patentees believe.

The Utah Leasing Co. at Newhouse dismantled its 700-ton flotation mill and shipped all the copper slimes resulting from the last operations of its mill on the old Cactus tailing dump. The machinery of the flotation concentration mill was moved to Colorado in 1919.

Star districts (North and South).—There were 611 tons of smelting ore shipped by 10 producers in 1919, containing $497 in gold, 10,359

[5] Horn Silver Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

ounces of silver, 15,868 pounds of copper, and 198,889 pounds of lead, valued in all at $25,591, or an average of $41.88 a ton. The principal properties producing were the Gold Crown, Monitor, Moscow, Red Warrior, Wild Bill, and Commonwealth.

BOX ELDER COUNTY.

Ashbrook district.—The Vipont mine was actively developed and a concentration mill using flotation was under construction in 1919, but no production was reported.

Lucin district.—The Copper Mountain mine of the Salt Lake Copper Co., which was operated largely by lessees, yielded oxidized copper ores, which, with some oxidized and sulphide lead ores, were shipped directly to the smelters near Salt Lake City. Development of the Tecoma mine by lessees was started late in 1919.

Newfoundland district.—According to the statement of the operator, lead ore, containing copper and silver, produced from the King Extension property and shipped to a smelting plant near Salt Lake, did not pay transportation and treatment charges under the high rates for freight and smelting which prevailed in 1919.

Park Valley district.—A small quantity of gold ore was recovered from ore treated at the Susannah mill, probably the result of a clean-up of the property.

Promontory district.—The Lake View mine produced a small quantity of lead-zinc ore, which was shipped to one of the eastern zinc plants.

JUAB COUNTY.

There was a marked decrease in quantity and value of ore mined in Juab County in 1919. The output was mainly from the Tintic district.

Fish Springs district.—The concentration mill erected to treat the old mine dumps of the Utah and Last Chance properties was operated during 1919, and lead concentrate, containing silver, was shipped to the smelter.

Mount Nebo district.—Lead ore, containing silver, was shipped from the Nebo Lead property.

Tintic district.—The production of the Tintic district for the year 1919 is reviewed under the Juab County heading, although a number of important mines on the east side of the district are in Utah County. The geology and history of the district are set forth in a recent Survey report.[6]

Mine production in Tintic district, Utah, 1918–19.

County.	Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
			Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Juab	1918	33	303,364	$627,976	4,982,060	5,895,925	25,397,992	167,179	$8,884,800
	1919	36	232,782	495,015	4,788,095	2,560,513	17,471,370	93,571	7,266,749
Utah	1918	8	59,130	50,976	1,699,584	672,877	5,254,366	97,641	2,298,706
	1919	8	64,150	40,519	1,991,734	690,495	6,991,793	.....	2,770,258
	1918	41	362,494	678,952	6,681,644	6,568,802	30,652,358	264,820	11,183,506
	1919	44	296,932	535,534	6,779,829	3,251,008	24,463,163	93,571	10,037,007
Total, 1869–1919	.....	.....	.....	33,771,422	138,733,155	181,313,445	807,164,947	17,162,044	201,622,317

[6] Lindgren, Waldemar, and Loughlin, G. F., Geology and ore deposits of the Tintic mining district, Utah: U. S. Geol. Survey Prof. Paper 107, 1919.

The value of the metals produced in 1919 was distributed as follows: Gold, $535,534, against $678,952 in 1918; silver, $7,593,408, against $6,681,644; copper, $604,687, against $1,622,494; lead, $1,296,547, against $2,176,317; zinc, $6,831, against $24,099.

The ore sold or treated in the district in 1919 averaged $33.80 a ton, compared with $30.85 in 1918.

Mine production in Tintic district, Utah, in 1919, by kinds of ore.

Kind of ore.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry and siliceous	32	172,984	19,049.30	3,083,829	2,047,223	575,394	.....
Copper	4	5,502	307.22	47,349	525,695	.....	.....
Lead	25	118,276	6,542.95	3,647,931	674,873	23,882,561	.....
Zinc	1	151	.....	.....	.....	.....	93,571
Copper-lead	1	19	6.94	720	3,217	5,208	.....
	.....	296,932	25,906.41	6,779,829	3,251,008	24,463,163	93,571

The Chief Consolidated Co., the leading producer of silver in the State, shipped a larger output of ore and did more development work than any other company in the region, principally on and below its 1,400-foot level. Besides developing its mine in the town of Eureka, the company prospected with the diamond drill its holdings north and east of Eureka. According to the annual printed report [7] of the company, the total shipments of ore in 1919 were 63,726 dry tons, yielding, after smelting, transportation, and sampling charges, $2,343,926.80. This represented the amount received for the ore from the smelting company, and after the deduction of other charges the net profit was $664,720.17. The sum of $282,954.24 was disbursed to stockholders in four dividends. A comparison of the output of the mine in 1918 and 1919 follows:

Ore and metal production of Chief Consolidated mine.

Year.	Ore.	Gold.	Silver.	Lead.	Copper.	Zinc.
	Dry tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1918	66,019	4,100	2,354,798	7,906,831	4,137	14,597
1919	63,726	3,753	2,757,533	5,979,588	15,574	.....
1909–1919[a]	403,547	50,067	12,369,776	62,823,420	382,383	2,188,373

[a] The production of the Chief Consolidated mine by years is given in Mineral Resources, 1918, pt. 1, p. 388.

Of the ore shipped, 25,080 tons was lead ore with an average content of 0.0589 ounce of gold and 43.272 ounces of silver per ton, 11.92 per cent of lead (in lead ore), and 1.186 per cent of copper (in copper ore). The average total value of all ores was $55.57 a ton. Smelting, freight, and sampling cost $18.79 a ton, leaving a net average value of $36.78. The mine operations were given as follows in the printed report of the company:

Development work was pursued on the first or oldest ore zone on all levels from the 600 to the 1,900. On the second ore zone development was confined to the levels

[7] Chief Consolidated Mining Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.

from 1,600 to 1,900. Some evidence of a third zone was developed in the last quarter. Ore was produced from all the ore channels and from all the levels. An increase in the number of producing places is noted.

In development and the production of ore below the 1,800 level, the amount of water has increased to 1,000 gallons per minute. Pump installations are such that no delay is experienced from this flow, and the new pumps we have on hand will, when installed, double the present capacity. The draining of large areas in the vicinity of the ore bodies is evidenced by the slight increase in flow as development proceeds.

On January 1, No. 2 shaft was down 970 feet and concreted to 916 feet. In January the shaft will be completed to the 1,000-foot level where connection will be made with the 1,000 drift driven for this connection and completed in November last.

The Chief Consolidated Co. failed to discover ore of shipping grade in the Plutus mine, which is under lease, but the results of the work of exploration are said to grow more promising as work proceeds.

Operations continued in 1919 at the Centennial-Eureka mine, which for 35 years has produced ore containing gold, silver, lead, and copper. Its output in 1919 was 21,288 tons by the company, which contemplates putting it under the leasing system in the near future. The old stopes have been practically worked out, but exploration continues in the vicinity of these stopes and in the areas that have not heretofore been explored.

At the Bullion-Beck property lessees worked with satisfactory results and shipped 2,018 tons of copper and lead ore during 1919.

At the Tintic Standard mine two new stopes were opened on the 1,250-foot level and one on the 1,350-foot level at the No. 2 shaft, where a large body of first-class ore was found. During the year considerable mill ore was developed from this shaft, thus adding largely to the reserves. Shaft No. 1 was sunk to the 1,250-foot level and enlarged to three compartments for its entire depth. It is intended to open up the property to the south from this shaft. About 56,000 tons of ore was shipped in 1919, and dividends paid to stockholders amounted to $552,250. The Goshen Valley Railroad was completed for 5 miles, and hauling for the intervening distance to the Standard mine was done by automobile trucks. The railroad when completed will be 10 miles long and will serve not only the Standard mine but all the mines south of it in the vicinity of the Iron King mine. At the Iron King the shaft was sunk to the 1,300-foot level. The increasing temperature at this depth is regarded by miners in the district as a favorable sign for sulphide ore bodies.

The output of ore from the Eagle & Blue Bell mine [8] decreased from 40,370 dry tons in 1918 to 22,174 dry tons in 1919 and consisted principally of carbonate lead ore with some sulphide ore. The lead ore shipped (20,070 tons) contained 1,092.64 ounces of gold, 345,952 ounces of silver, 4,906,555 pounds of lead, and 3,634 pounds of copper, valued in all at $565,397.13. After charges for freight, smelting, and sampling were deducted, the net smelter returns amounted to $318,598.19. The dry or siliceous ore, of which 2,104 tons was shipped, contained 312.06 ounces of gold and 36,764 ounces of silver, valued in all at $48,500, and after freight and treatment charges returned $26,636.81. In 1918 the total dividends disbursed amounted to $267,943.80. Dividends distributed in 1919 amounted to $89,314.60, half of which was paid from reserve for depletion account as return of capital. The total dividends paid since Feb-

[8] Bingham Mines Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.

ruary 1, 1913, including those of 1919, amount to $1,250,404.40. Reviewing development the company report says:

The 1,550 ore body supplied the bulk of the tonnage shipped. At various places where there was pronounced cross-fissuring extensions made off laterally from the main ore body and in some cases formed bulges of comparatively large size. In one instance stoping on one of these extensions was continued right up to the 1,350 level, and in another the workings on the 1,550 were connected by continuous stopes down to the 1,875 level.

In two of the producing mines in Tintic, one of which adjoins the Eagle, an enrichment of silver was found near and below the water level. Inasmuch as the No. 1 shaft is down to water level, which is 2,016 feet in the Eagle & Blue Bell mine, the 2,000 level was extended easterly across the ore zone. A number of good indications were encountered, but no ore found. However, a deposit of low-grade quartz was followed by a winze for 60 feet below the 1,875 level, and a crosscut is now being driven on the 2,000 level to a point directly under the winze.

The most important development during the year was toward the south and above the 1,350 level. In 1918 this level penetrated low-grade quartz for a distance of 160 feet. Recent work within this quartz has opened up a very promising body of lead-silver. The openings here have already reached a point 100 feet above the level and offer the best evidence of good future prospects for the ore-bearing ground, which continues to the southern limits of the Eagle and Victoria properties, a distance of about 1,700 feet.

The prospects in the northern part of the property are likewise very promising. In addition to a limited amount of development in the North Extension claims on the 1,000, 1,200, and 1,350 levels, the 1,550 level was extended northerly 725 feet into this ground. The work is still under way, and a favorable ore disclosure is expected within the next hundred feet.

From the Dragon property [9] considerable iron ore for flux was shipped to the smelters in Salt Lake Valley. The net return from this ore was $72,899.91, and $13,331.46 was received from the ore mined by the Tintic Milling Co. as lessee. Although a very small profit is made in the sale of ore mined, the lessees occasionally develop pockets of high-grade gold ore which has possibilities of materially increasing the royalty to the company.

Ore sales in 1919 from the Colorado mine [10] amounted to $107,435.93 from the operations of lessees, who cleaned up some of the old stopes and followed small veins. A steady output of low-grade silver ore was also shipped to the Tintic mill at Silver City. The work in the mine is reviewed in the company report, as follows:

To a large extent the exploration work for the past year was undertaken, primarily, for the purpose of determining geological conditions, which it was hoped would be of value in determining further search for new ore bodies.

At the close of the year both prospect and exploration work was discontinued indefinitely, as the year's campaign had neither developed ore nor given new leads which, in the judgment of the management, justified further development expense under present conditions. * * *

From the No. 1 shaft on the 250-foot level 71 feet of drifting was done in a northerly direction, on what is known as the West Break, without a satisfactory development.

From the No. 4 shaft considerable drifting, raising, crosscutting, and sinking has been done on different levels. * * *. The ore produced from this work has barely paid costs.

On the 1,100-foot level we have extended the east crosscut 65 feet, which developed a large bed of soluble limestone (generally considered ore bearing). This work disclosed a large cave with an oxide filling, but no ore. * * *

On the 1,914-foot level we extended from the No. 4 shaft, the south drift, a distance of 1,229 feet. This drift encountered a large open fissure striking southwest. It appeared of sufficient importance to drift south on this for 700 feet, but finally it was abandoned, as conditions did not improve.

[9] Dragon Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1919.
[10] Colorado Consolidated Mines Co. Ann. Rept. for year ending Dec. 31, 1919.

During 1919 the Empire mines [11] yielded a small output of ore, which sold for $17,427.45, largely the result of the work of lessees in cleaning up the old stopes. Concerning the opening of some of the famous producers, the company report says:

From the No. 2 shaft, known as the Lower Mammoth, we extended the east crosscut on the 1,800-foot level 1,232 feet, into what is commonly known as the old Star territory. This crosscut work at the time of this report is of considerable interest, as it is directly underneath immense quartz croppings showing on the surface and also vertically beneath the upper levels of the old Star mine, which produced ore during the operation of that property as an independent corporation. This work is at a depth of 2,000 feet, or 1,200 feet lower than the deepest work from the old Star shaft, thus giving 1,200 feet of virgin territory above the present workings. * * *

We are sinking a winze on the side lines of the Opohongo and Empire ground, with a splendid showing of lead, copper, and silver ores. * * *

The opportunity to prospect the old Spy section of this territory at a much greater depth than anything heretofore attempted is by working through the 1,700-foot level of the Iron Blossom Co.'s No. 1 shaft. We have drifted 482 feet west from the Iron Blossom west side line. * * *

The operators of the Iron Blossom mine [12] in 1919 received for ore sold $417,877.87. Dividend disbursements amounted to $50,000. Most of the ore mined was produced under the leasing system in various parts of the mine. Work was carried on in No. 1 shaft in ore a short distance below the 1,700-foot level, and on the 2,185-foot level, a crosscut was extended to explore at depth the great outcrop of quartz showing on the Oconook and Una claims. A small stringer of lead-silver ore striking north was followed for 240 feet without any improvement, owing to the highly siliceous condition of the limestone at this horizon. Continuing, the company report says:

We also extended the northeast drift from this same level for 372 feet, prospecting the section of territory directly in line and under known ore deposits on levels above, but without satisfactory results.

From No. 3 shaft we crosscut west from the 1,700-foot level to explore territory directly underneath the producing levels of the mine near the surface as well as to cut underneath territory which showed meritorious surface indications.

The Tintic Milling Co.,[13] at Silver City, while engaged in a general custom-milling business in 1919, leased several mines in the Tintic district and produced ore from them. A large quantity of low-grade siliceous silver ore was milled by the chloridizing roasting process, and the product, a base bullion, was sold to an eastern refinery, netting the company $640,519.36. The expense of operation in 1919 amounted to $558,587.57 and depreciation and taxes to $50,561.16, leaving a net profit of $31,370.63. An electrolytic refinery for treating the bullion produced was to be added in 1920, thus saving the lead content in addition to the gold, silver, and copper, which were the only metals paid for in the sale of the bullion.

At the Victoria mine [14] 3,346 dry tons of ore was mined, of which 2,999 tons was classified as lead ore and 346 tons as siliceous ore, which contained some copper. The ore mined contained 385 ounces of gold, 47,961 ounces of silver, 544,418 pounds of lead, and 10,489 pounds of copper, valued in all at $78,305.78, giving net smelter

[11] Empire Mines Co. Ann. Rept. for year ending Dec. 31, 1919.
[12] Iron Blossom Consolidated Mining Co. Ann. Rept. for the year ending Dec. 31, 1919.
[13] Tintic Milling Co. Ann. Rept. for year ending Dec. 31, 1919.
[14] Bingham Mines Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.

returns of $39,185.09 after the deduction of all freight, smelting, and sampling charges. The company report says:

Operations for 1919 were conducted on a comparatively small scale. All the underground work was carried on through the Eagle and Blue Bell No. 1 shaft by means of extensions to the various levels in the latter mine.

The unfavorable metal market and labor conditions did not permit the exploitation of the available faces of low-grade ore, and very little exploratory work was done. Every ore showing which could be worked at a profit was exploited, and known ore bodies were developed by extensions into Victoria ground. These extensions were all small, consequently the production does not compare favorably with that for 1918.

MILLARD COUNTY.

Antelope district.—Although no ore was shipped from the Antelope district, the East Antelope property was under development from February to the end of 1919.

Detroit district.—Small development operations at the Copper Head claim resulted in the production of a small quantity of gold.

MORGAN COUNTY.

Argenta district.—Lead ore, containing silver, was shipped from the Carbonate group, operated by the Utah Silver-Lead Mining Co.

PIUTE COUNTY.

Gold Mountain district.—The Annie Laurie mine, operated by lessees, yielded a small quantity of gold ore, containing silver.

Mount Baldy district.—Successful operations at the Deer Trail mill resulted in the shipment of lead concentrate and some gold and silver bullion recovered by cyanidation. The company is mining an ore of which 60 per cent is oxidized and the remainder is sulphide, requiring concentration and cyanidation of the tailing. The mill on the property is equipped with an American filter and four concentrating tables. In addition to the ore milled, there was some lead ore, containing silver and copper, shipped directly to the smelter.

Ohio district.—At the Bully Boy and Webster property some of the drifts were cleaned out and a small output of ore, containing lead and silver, was shipped. Shipments of silver ore were also made from the Branch and Deseret property, and a very rich lot of ore was shipped from the Wedge mine, operated by lessees. The Tushar Range property was actively developed, but no output was reported.

SALT LAKE COUNTY.

Salt Lake County underwent the greatest decline in output, as shown on page 423. This was due to curtailment of production of low-grade disseminated copper ore. A review of the principal districts follows.

Big Cottonwood and Little Cottonwood districts.—Of the 19 producers in these districts 6 were on the Big Cottonwood side of the divide and 13 in the Alta region. Their output averaged $36.56 a ton.

Mine production in Big Cottonwood and Little Cottonwood mining districts, Utah 1918-19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	23	35,269	$12,066	482,136	1,715,969	6,007,253	1,121	$1,344,663
1919	19	21,766	7,947	321,426	916,049	4,857,211	.....	795,761
Decrease, 1919	4	13,503	4,119	160,710	799,920	1,150,042	1,121	548,902
Total, 1867–1919	.....	486,530	520,542	13,943,907	12,487,935	191,481,249	322,055	27,862,977

The principal producer in the Big Cottonwood district was the Cardiff property, from which lead ore, largely oxidized, was shipped. Other properties yielding ore were the Woodlawn, Iowa Copper, Howell, Maxfield, and Carbonate. Properties producing in the Little Cottonwood district were the South Hecla, Michigan-Utah, Rexall, Sells, Emma, Alta Consolidated, Louise, Wasatch Mines, and Cabin.

Shipments of ore were greatly retarded during 1919 on account of the almost impassable condition of the team road for the greater part of the year. This, together with the shortage of labor and the fact that the Little Cottonwood Transportation Co. did not commence operating its railroad from Wasatch to Alta until May 13 and discontinued operations December 8, greatly reduced the output. This company handled about 125 tons of ore a day and could have doubled the quantity if necessary. Freight rates were $1.70 and $1.90 a ton to Wasatch, and charges from there to the smelters on the Salt Lake & Alta Railroad ranged from 90 cents to $1.50, making a total of $2.80 to $3.40 a ton, or about $1 less than the former wagon-hauling charge.

From the South Hecla mine [15] 7,847 dry tons of ore was shipped to the smelter, 7,634 tons by the company and 213 tons by lessees. The total output contained 111.51 ounces of gold, 73,818 ounces of silver, 361,428 pounds of copper, and 73,555 pounds of lead. The ore also contained 4,159,000 pounds of iron, which reduced the smelter treatment charge. The company report gives an account of the development work as follows:

> During the year the ore developments on company account have been confined mostly to the Wedge vein, which had been opened near the western end of the property by the so-called Wedge shaft, and levels driven along the vein at an average depth of 350 feet on its dip and by some limited but important workings on the eastern end of the vein systems over a mile away from the main development. The development carried on in the Wedge vein during this year was from the 500-foot level. The lead stopes on the west side of the mine were opened on the 500-foot level, and the ore body on this level appears to be fully as large as on any of the levels above, and the grade of same is much better, both in silver and copper content. During the early part of the year exploration work was commenced on the eastern end of the vein system in the sulphide zone, and where the Wedge vein was penetrated a large body of copper-silver sulphide ore was encountered.
>
> The small amount of exploration work done during the year on mine development account at different points on the Quincy and the Dwyer levels did not materially add to the direct smelting ore reserves of the mine; large veins of milling grade ores have been opened, but as our efforts have been to get direct smelting ore, we have

[15] South Hecla Mining Co. Ann. Rept., for year ending Dec. 31, 1919.

not as yet explored these low-grade veins to any great extent. The company owns a total of 600 acres of mineral land in the Alta district, of which less than 10 per cent has been explored.

The Wasatch mines adit was continued to a point 5,080 feet from the portal. Its face is in the proximity of the old shaft leading to the 400-foot level of the Columbus mine, which is gradually being drained.

Shipments of ore from the Columbus-Rexall mine [16] in 1919 consisted of 1,226 tons of first and second class copper ore and 110 tons of silver-lead ore, for which the smelter returns were $18,592.27. Mining of copper ore was discontinued on account of the low price of copper, and development was devoted to the opening of a body of silver-lead carbonate ore discovered in April. The main working tunnel is more than a mile in length and makes connection with the 600-foot level of the Cardiff mine. From 1917 to the end of 1919 the mine has produced 9,742 tons of ore, for which the smelting company paid $276,214.64. In July drifting was started in the adjoining Cardiff mine on the 800-foot level to open the neighboring Kennebec property.

The total value of the silver ore produced from the Emma mine since its discovery to August, 1919, as estimated by the company geologist,[17] was $3,825,000. This agrees very closely with the estimate made by the United States Geological Survey. Beginning in January, 1917, extraction of ore was pushed far beyond the development work or beyond the point where the ore could be economically mined. Without ample funds to keep up development, the mine was closed in August, 1918, and a receiver was appointed. During this period the net smelter returns for 10,362 tons of ore shipped amounted to $273,742, or an average net value of $26.41 a ton. In the latest reorganization of the Emma property the Joab Lawrence claims [18]—the Vallejo and the North Star, situated between the Emma and the Flagstaff mines—were included, and though they were productive up to the time of reorganization no ore was shipped in 1919. All attention was given to unwatering the Emma mine from the winze in the Bay City tunnel and also from the winze which extends down about 80 feet below the 300-foot level and in which mining of the ore began in November, resulting in several shipments to the smelters before the end of 1919.

Smelter district.—At Murray and Midvale the lead smelting plants continued their operations uninterruptedly, except for the usual curtailment due to shortage of custom ore in the winter. Low temperature, which results in ore freezing solid in the cars, made the unloading of the ore extremely difficult. This, with the results of the epidemic of influenza, added to the burdens of the operators.

The United States Co.[19] reports the smelting of 215,620 tons of marginal ore in 1919 and the production of 32,580 tons of lead bullion. The lead bullion output was less than in 1918, the result largely of reduced receipts of custom ore, which was attributed to the lower price of lead. The company report says:

> The improved metallurgy of the plant was especially gratifying. By-products are an important feature of this operation. Here, not only mixed ores containing gold,

[16] Columbus-Rexall Consolidated Mines Co. Rept., June 7, 1920.
[17] Beeson, J. J., Emma Silver Mines Co., report reviewing the history and giving a geologic summary of the property at Alta, Utah, 31 pp., 1919.
[18] Joab Lawrence property described in Tenth Census, vol. 13, 1880, p. 424.
[19] United States Smelting, Refining & Mining Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1919.

silver, lead, and copper are reduced, but the less common metals are in large measure recovered. Litigation that has been pending with farmers in the vicinity of Midvale for many years and which culminated in a complaint for injunction that was heard in 1916, resulted in an agreement between the parties to have the merits of the dispute tested during the coming year by a commission appointed by and reporting to the Federal court of the district.

Bingham or West Mountain district.—The metal output of the Bingham district in 1918 and 1919, and the total output between 1865 and 1919 are shown in the accompanying table. Total dividends (partly estimated) to date have amounted to $112,440,373. The production by years to the end of 1913 may be consulted in Mineral Resources for 1913, part I, page 399.

Mine production in Bingham or West Mountain district, Utah, 1918–19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	36	13,607,650	$2,056,005	2,437,758	211,194,861	79,773,150	5,739,150	$62,845,050
1919	29	6,086,379	1,389,849	1,607,132	116,696,528	54,610,987	2,566,376	27,977,118
Decrease, 1919	7	7,521,271	666,156	830,626	94,498,333	25,162,163	3,172,774	34,867,932
Total, 1865–1919	.....	.....	34,764,044	52,460,714	1,986,528,255	1,192,476,675	48,358,244	510,521,856

The average value of the ore produced in 1919 was $4.60 a ton, against $4.62 in 1918. The output of silver decreased from $2,437,758 in 1918 to $1,799,988 in 1919, copper from $52,165,131 to $21,705,554, lead from $5,663,894 to $2,894,382, and zinc from $522,262 to $187,345. The shipments of ore to the smelters amounted to 258,781 tons, against 468,862 tons in 1918. The output of concentrating ore was 5,827,598 tons, against 12,919,580 tons in 1918. The quantity of concentrates produced was 339,648 tons in 1919, against 741,015 tons in 1918.

The crude smelting ore in 1919 consisted principally of low-grade copper and lead sulphides and contained 15,573.68 ounces of gold, 811,689 ounces of silver, 8,128,543 pounds of copper, and 33,241,667 pounds of lead, valued in all at $4,504,745, or an average of $17.41 a ton. Milling ores produced 339,648 tons of copper, lead, and zinc concentrates that contained 51,660.26 ounces of gold, 795,443 ounces of silver, 108,567,281 pounds of copper, 21,369,320 pounds of lead, and 2,566,376 pounds of recoverable zinc, valued in all at $23,472,241 or an average of $69.11 a ton.

Mine production in Bingham district, Utah, in 1919, by kinds of ore.

Kind of ore.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ozs.*	*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry or siliceous	4	23,538	1,525.62	100,247	520,868	.....	.....
Copper	14	5,819,006	38,209.56	454,701	114,194,311	.....	.....
Lead	18	109,785	5,063.76	549,925	1,387,265	33,955,227	.....
Lead-zinc	3	134,050	22,435.00	502,259	594,084	20,655,760	2,566,376
	.....	6,086,379	67,233.94	1,607,132	116,696,528	54,610,987	2,566,376

The Utah Copper Co.[20] produced in 1919 by steam-shovel mining 5,538,700 tons of concentrating copper ore and by underground methods 492 tons. These figures compare with a total of 12,160,700 tons of ore concentrated and 34,769 tons of ore directly smelted in 1918. Since the beginning of operations 84,920,100 tons of porphyry ore, averaging 1.39 per cent of copper, has been produced from the entire property. At the Magna plant 365,600 tons of ore was milled in 1919 and at the Arthur plant 5,173,100 tons. The output represents a decrease of 6,259,400 tons at the former and 362,600 tons at the latter plant as compared with the output of 1918. The total quantity of copper in concentrates was 109,234,920 pounds, and the average grade of concentrate was 19.86 per cent of copper as compared with 194,168,589 pounds and 16.08 per cent of copper, respectively, for 1918.

Active operations at the leaching plant were suspended January 1, 1919, and no ore was received from the mine during the year. The leaching of all ore in the vats was completed, with the exception of 1,608 tons, and intermittent shipments of cement copper precipitates resulting from previous operations amounted to 1,284 tons, averaging 51.248 per cent of copper. The gross production of copper for the year 1919 from all sources was 110,591,608 pounds. After making smelter deductions the net production was 105,088,740 pounds of copper, 28,906.63 ounces of gold, and 263,721 ounces of silver, valued in all at $19,554,541.17. There was a distribution in 1919 of $9,746,940, of which $1,949,388 was dividends and $7,797,552 was capital distribution. The following is taken from the company report:

In order to provide additional water for the enlarged concentrating plants some lakes were purchased in what is known as the East Lakes drainage district, about 6 miles east of Magna. These lakes cover an area of about 231 acres and are connected by the Riter Canal with the pond at No. 1 pump station, near the old steam power plant. Some small tracts of land in the vicinity of the Magna plant, aggregating about 49 acres, were also purchased during the year. The area of land other than the lode claims now owned by the company totals 11,133.45 acres. * * *

During the early part of the year operations were put on a curtailed basis at approximately 50 per cent of normal, and on February 26, 1919, the Magna plant was shut down. The total ore treated at both plants was 5,538,700 tons, as compared with 12,160,700 tons for the year 1918.

The average grade of ore milled at both plants was 1.26 per cent copper as compared with 1.23 per cent copper for the previous year. The average recovery for both plants combined was 78.46 per cent, corresponding to 19.7221 pounds of copper per ton as compared with 65.11 per cent and 15.9669 pounds per ton for the year 1918. The average cost of milling at both plants was $1.2062 per ton, being an increase of 27.85 cents per ton over costs for the previous year. This increase was due to the lesser tonnage and the higher cost of supplies. * * *

The total amount of copper contained in leaching plant precipitates was 1,320,672 pounds. Copper contained in direct smelting ore amounted to 36,016 pounds. The gross production of copper for the year 1919 from all sources, as compared with 1915, 1916, 1917, 1918, and 1919, was as follows:

Quarter.	1915	1916	1917	1918	1919
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
First	26,415,995	36,673,007	43,060,450	41,276,750	29,261,209
Second	40,799,825	48,726,304	56,845,059	52,724,053	28,046,978
Third	44,766,841	61,181,870	54,999,468	54,739,678	25,269,679
Fourth	44,224,715	50,836,299	51,269,465	49,238,076	28,013,742
	156,207,376	197,417,480	206,174,442	197,978,557	110,591,608

[20] Utah Copper Co. Fifteenth Ann. Rept., for year ending Dec. 31, 1919.

The average cost per pound of net copper from concentrates only was 14.226 cents, while the cost of that recovered from all sources, including concentrates, sulphide ore, and leaching plant precipitates, was 14.145 cents, as compared with 16.331 cents for the previous year. In stating these figures no account is taken of the income derived from gold and silver and from miscellaneous sources, but they include depreciation reserves, all local and State taxes, all fixed, general, and maintenance charges of every kind, and all expenses of smelting, transportation, refining, and selling. The net value of the gold and silver recovered was 0.831 cent per pound of copper, and the miscellaneous income in Utah, including that from the Bingham & Garfield Ry., amounted to 0.948 cent per pound, making a total income from these sources of 1.779 cents per pound. Applying this income as a reduction in the cost of producing copper would bring the per pound cost of 1919 to 12.366 cents, as compared to 12.53 cents for 1918, calculated on the same basis with Federal taxes eliminated for comparative purposes. The per ton operating costs on concentrating ore, including all fixed, general, and maintenance charges for the years 1918 and 1919 are shown below:

Year.	Ore.	Mining.	Transportation.	Milling.	Total.
	Short tons.				
1918	12,160,700	$0.5370	$0.2983	$0.9277	$1.7630
1919	5,538,700	.4900	.3040	1.2062	2.0002

From the United States Co.'s mines [21] 137,916 wet tons of complex lead ore and zinc crude ore and 710 wet tons of copper ore were shipped. The company report contains the following:

The output was maintained with uniformity during the year except for a short period after June 29, when an underground fire caused suspension of work until the burning area could be bulkheaded. In the fore part of the year, high costs of production, transportation, and reduction resulted in little or no profit on the low-grade milling ores, but the mine earnings responded to the improved price for silver, lead, and zinc in the latter half of the year. Your Bingham mines have not been developed within a vertical depth of 1,100 feet of the lowest known horizon of ore deposition in the district. It is altogether probable that the fissures which are producing ore at present will continue to greater depths, yielding ore at lower horizons in the same ratio as at higher elevation.

From the Dalton & Lark mines [22] the company reports shipping lead-silver ore, copper ore, and some ore by lessees. The lessees continued to operate in the old workings of the Dalton & Lark and Commercial mines and produced 4,730 tons of ore, on which the company received as royalty the sum of $34,933. Dividends amounting to $112,500 were paid during 1919. The output of the company in 1919, exclusive of ore mined by lessees, was as follows:

Mine production by Dalton and Lark mines, Bingham district, Utah, 1919.

Kind of ore.	Ore.	Gold.	Silver.	Lead.	Copper.	Gross value.	Smelter returns.
	Dry tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*		
Lead ore	400.62	17.28	3,506.23	82,955	9,993	$7,293.80	$4,067.21
Copper ore	21,994.56	1,463.66	86,691.89	.....	484,374	141,488.42	95,401.19
	22,395.18	1,480.94	90,198.12	82,955	494,367	148,782.22	99,468.40
Company and lease ore produced, 1909–1919	.....	29,097	2,429,876	12,658,807	37,343,451	.....	.....

[21] United States Smelting, Refining & Mining Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1919.
[22] Bingham Mines Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.

After reviewing this tabular statement, the company report says:

Work, company account, was confined almost entirely to the development of the Brooklyn ore body. From time to time in the Brooklyn, zones of impoverishment have been encountered which in due course have again given place to higher-grade ore. During 1918 the east drift, 200 feet below the Mascotte tunnel level, was extended 620 feet easterly from the Brooklyn winze, with raises and sublevels at intervals, but very little ore of commercial grade was developed. Early in 1919 a raise was made near the face of the 200 east drift and this encountered a marketable grade of ore. Further development work here resulted in opening up an ore body 350 feet wide, 110 feet long, and averaging 6 feet thick.

The ore reserve in the Brooklyn above the Mascotte tunnel level has nearly been depleted, but recent developments indicate splendid possibilities above the tunnel east of the present openings.

Operations were continued at the Yosemite mine [23] in a small way during 1919. A total of 1,195 dry tons of lead ore and 841 dry tons of copper ore was shipped, containing 109.69 ounces of gold, 10,705 ounces of silver, 445,667 pounds of lead, and 25,324 pounds of copper, valued at $29,335.03, giving net smelter returns of $20,109.43 after the deduction of freight, smelting, and sampling charges.

On the 850 and 900 foot levels, Lead Mine vein, the development work on the Cluster ore shoot consisted of several hundred feet. From these workings a small tonnage of lead-silver was mined. The ore was followed below the 900 and is making down strong. Rather than continue the winze, it was deemed advisable to extend the 1,100 level southwesterly along the vein to develop this ore at greater depth, and also to explore the undeveloped section of the vein east of the present openings. The 1,100 level was advanced 382 feet. The Cluster shoot should be intercepted within the next 500 feet. The prospects in and near the face are favorable, and another shoot of ore should be encountered before the main objective is reached.

In 1919 the Highland Boy mine [24] produced 5,710,346 pounds of copper, 13,072,177 pounds of lead, 373,179.67 ounces of silver, and 10,548.147 ounces of gold. No dividends were distributed during the year on account of the expense which will be involved in the erection of a 1,000-ton concentration mill at International, Utah. From the annual report of the company the following figures are taken:

Average assay per ton of crude ore shipped from the Highland Boy mine, Utah, in 1919.

Material.	Dry ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*
Copper-iron sulphide ore	124,199	0.07	1.27	2.22	.....
Lead sulphide ore	45,377	.41	5.34	.82	17.50
Copper concentrate	302	.18	3.10	10.29	.....

The copper concentrates were produced from the milling of 2,694 tons of ore at the mill of the Utah Metal & Tunnel Co., which was leased for four months. The company report says:

Sinking operations in the vertical shaft were continued 400 feet to the 2,000 level. The whole distance was in the Highland Boy limestone, and as the dip of the lode has steepened to nearly 80 degrees it is not expected that the quartzite footwall will be cut until the 2,400 level is reached. An additional 400 feet will be sunk this year

[23] Bingham Mines Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.
[24] Utah Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

(1920), which will bring the shaft to the 2,400-foot level, where the bottom main pumping equipment will be installed. The pumping will then be done in two lifts of 800 and 850 feet, respectively.

On the 1,600 the west drift in the Highland Boy limestone has so far cut two lead ore bodies. One of them is small, but looks promising, and the second is the continuation of the ore found in the upper levels. This ore is holding up both in size and grade. It was found that the limestone was more mineralized on the 1,600 than on the 1,300.

There was 5,023 feet of work done in the upper limestone on the 1,200, 1,300, 1,500, and 1,600 levels. The main ore body extends for a distance of 1,100 feet on the strike on the 1,200 and 1,500 feet on the 1,600, with an average width of 4 feet and an average assay of 2.18 per cent copper, 0.05 ounce of gold, and 0.85 ounce of silver. This ore body was also cut on the 1,800 level, where it has been drifted on for 180 feet. The width here is 6 feet and the ore assays 2.26 per cent copper, 0.05 ounce of gold, and 0.70 ounce of silver.

To the west in this lode additional good ore bodies have been found away from the footwall.

A crosscut north on the 2,000 level has passed through a low-grade copper ore body 30 feet in width in the Highland Boy limestone. The Highland Boy limestone for several hundred feet in depth in this part of the mine has been sparsely mineralized, and it is therefore most encouraging to find ore coming in again.

Drifting in the upper limestone above the California has continued to open up good shipping lead ore.

According to the report of the Utah Apex Mining Co.[25] the proceeds from the sale of ore and concentrate during the fiscal year amounted to $981,939.76 and from royalties on leases $6,718.96. The mining expense was $501,078.24, development $330,492.80, and milling $50,422.87.

The Montana-Bingham Consolidated Co.[26] in 1919 confined its underground work to that part of the mine opened by the adit tunnel, which has its portal on the easterly side of lower Bingham Canyon. Development of the Fortuna property, recently acquired, disclosed an ore deposit in the Mayflower vein, which was opened for 500 feet along its strike and found to range in thickness from a few inches to 6 feet. This vein is well defined and the ore occurs as a replacement of a bed, which has an average dip of 28° W. Although the ore from this deposit is not uniform in grade, it was found profitable to ship about 3,500 dry tons, containing gold, silver, copper, and occasionally some lead, which netted the company about $72,000. In addition to these shipments the lessees mined about 600 tons of copper and lead ores, which netted $9,147.

At the Utah Metal & Tunnel mine[27] 80 men were employed in 1919, particularly in the Malloy region, where six stopes are opened, besides four others in other parts of the property. Gross ore sales amounted to $94,148.22, including smelting charges of $27,087.98 and mining, milling, and development charges of $37,586.04.

The Ohio Copper Co. made some mineral separation tests during part of 1919 and shipped copper concentrate to the Garfield smelter. Operations at the mine and mill were suspended in March, 1919.

SAN JUAN COUNTY.

Early in 1919 it was reported that the Big Indian mine and mill of the Buena Vista Copper Co., in the Big Indian district, had been leased to the Metallurgic Improvement Association, which has a process for extracting copper from carbonate ores. Development work was done, but no production of metals was reported.

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[25] Utah Apex Mining Co. Ann. Rept. for year ending Aug. 31, 1919.
[26] Montana-Bingham Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1919.
[27] Utah Metal & Tunnel Co. Ann. Rept. for year ending Dec. 31, 1919.

SUMMIT AND WASATCH COUNTIES.

The principal producing area in Summit and Wasatch counties is the Park City region, which embraces the Blue Ledge, Snake Creek, and Uinta districts. The output, wholly from the last two districts, is shown in the table below. The total amount of the dividends from the region for the period 1870–1919 is $44,462,115.

Mine production in Park City mining region, Utah, 1918–19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	11	167,329	$82,461	2,572,586	915,649	24,320,074	3,430,934	$4,920,153
1919	11	147,850	69,502	1,945,670	760,858	21,311,284	1,279,556	3,613,078
Decrease, 1919	.....	19,479	12,959	626,916	154,791	3,008,790	2,151,378	1,307,075
Total, 1870–1919	.....	.....	4,519,141	139,818,066	32,705,063	1,298,076,222	70,901,675	178,347,255

The mines in the Park City region were not operated with a full force at any time during 1919 because of the shortage of men. Operations were difficult on account of the poor market for ores and the small percentage of efficiency obtainable from the men employed.

The crude ore shipped directly to the smelters consisted of siliceous ore and mixed lead carbonates and sulphides, aggregating 47,993 tons, and contained 2,408.78 ounces of gold, 1,531,208 ounces of silver, 584,495 pounds of copper, and 11,731,431 pounds of lead, valued in all at $2,495,229, or an average of $51.99 a ton. The remainder of the ore (92,092 tons) was milled and produced 19,891 tons of concentrates, including those from 7,765 tons of creek tailings. The concentrates contained 953.39 ounces of gold, 414,462 ounces of silver, 176,363 pounds of copper, 9,579,853 pounds of lead, and 1,279,556 pounds of zinc, valued in all at $1,117,849, or an average of $56.20 a ton. In 1918 the average value per ton of shipping ore was $48.55 and of concentrates $72.16.

From the Silver King Coalition mine [28] 54,513 dry tons of ore was mined, of which 43,476 tons was milled, yielding 7,596 dry tons of lead concentrate and 827 tons of middlings. The average assay contents of these products were reported as follows:

Kind of material.	Gold.		Silver.		Lead.		Copper.		Net smelter returns (value).	
	Per ton.	Total.	Per ton.	Total.	Percentage.	Total.	Percentage.	Total.	Total.	Per ton.
	Ounce.	*Ounces.*	*Ounces.*	*Ounces.*		*Pounds.*		*Pounds.*		
First-class ore	0.075	832.47	32.3	356,481	30.2	6,664,573	0.480	108,090	$596,224	$55.05
Concentrate	.080	601.59	21.4	162,456	26.9	4,085,383	.020	30,216	286,198	37.68
Middlings	.030	24.67	11.3	9,391	6.8	112,731	.046	7,610	3,520	4.25
	.....	1,458.73	.....	528,328	.....	10,862,687	.....	145,916	885,942	.....

[28] Silver King Coalition Mines Co. Ann. Rept. for year ending Dec. 31, 1919.

No dividends were paid from operations in 1918 or 1919.

The breast of the Spiro adit, which is to open all the undeveloped resources of the Silver King Consolidated property,[29] was 11,623 feet from the portal, having been driven a total of 2,622 feet in 1919. Labor troubles in the district, of which the King Consolidated had its share, were ended on June 22, after lasting about seven weeks. Work was then resumed at the King shaft, which had not been operated since July 30, 1918, and the incline from the 1,625-foot level was extended 110 feet to a point at which ore was found. Production from this section amounted to 761 dry tons.

The California-Comstock also produced milling ore, from which 572 tons of concentrate was recovered. The assay contents of each product as given in the annual report of the Silver King Consolidated Co. follow:

Material.	Quantity.	Gold.	Silver.	Copper.	Lead.	Value.
	Dry tons.	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per ton.*
Crude ore	780	0.062	31.55	0.22	28.44	$57.00
Concentrate	572	.044	16.45	.87	26.16	31.09

The total product sold contained 50.94 ounces of gold, 34,020 ounces of silver, 13,465 pounds of copper, and 742,944 pounds of lead, all of which was sold for $62,248.01.

Underground operations at the Daly West mine[30] were resumed March 1, when the lease of the Ontario Silver Mining Co. was terminated for the upper 1,500 feet of the Daly West mine. No attempt was made to operate the concentration mill on the property, as the Judge concentrator, owned by the same interests, was available and easily accessible. In the operation of the Judge and Daly West mines there is a cooperative agreement by which either company does the work underground on a straight cost basis. There were 4,789 dry tons of crude lead ore shipped to the smelter, together with 1,347 tons of concentrates and slimes, which had the following average metal content:

Material.	Quantity.	Gold.	Silver.	Copper.	Lead.	Value sold for.
	Dry tons.	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per ton.*
Crude ore	3,243	0.030	38.72	1.45	9.78	$34.97
Lease ore	1,546	.037	33.70	.97	11.32	24.38
Concentrates and slimes	1,347	.022	19.18	.64	6.80	21.38

In continuation the annual report says:

Two ore bodies have been opened up and are already yielding high-grade shipping ore. Two other headings which have not yet reached their objectives have produced

[29] Silver King Consolidated Mining Co. Ann. Rept. for year ending Dec. 31, 1919.
[30] Daly West Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

considerable shipping ore and offer great encouragement for the future. One * * * is prospecting the upper part of the Daly vein, which has been untouched in the Daly West, the other is following an extension of the middle vein, which has been a heavy producer in the Judge mine. It was formerly thought that this middle vein fault was identical with the great '02 fault of the Daly West mine, but a geological examination has disclosed the interesting fact that the two faults are independent and that the middle vein is unprospected in the Daly West mine. The importance of this discovery is obvious.

Operations were not started on the lower levels until the middle of November. Since that time this portion of the mine has been a steady producer of concentrating ore of good grade. * * *

Since the termination of the general mine lease to the Ontario Leasing Co., a system of individual leasing has been adopted. These leases have a royalty based on a sliding scale and are restricted in size to small areas in the worked out portion of the mine and will in no way conflict with any future exploratory work.

The Judge electrolytic zinc plant, about 1 mile east of Park City, was operated only during the first four months of 1919 and was then closed on account of the general labor strike which affected the district. Operations were not resumed until January, 1920. According to L. W. Chapman, who describes the plant and process in the Chemical and Metallurgical Engineering Journal for March 24, 1920, it was one of the first electrolytic zinc plants to be put into operation and was designed to produce 15 tons of zinc a day. However, under operating conditions that have developed, the plant will require enlargement in some departments to attain this tonnage. The roasting department will not supply sufficient calcine for more than 9 tons of zinc in 24 hours, which is about the present capacity of the plant.

Underground work at the Judge mine [31] was confined to daywork only for the first 11 months of 1919, so that the work accomplished represents operations at only one-half capacity. In continuation the annual report of the company says:

The new ore zone in the Back vein territory has been a heavy producer, and new ore found in this region proves that it will be an important factor in the production of the property for a long time to come. In the Daly vein a far-reaching discovery was the finding of a large deposit of high-grade milling ore in the footwall of the fissure. This footwall deposit represents a new condition of ore deposition in this territory, as all values found prior to this time have been either in the main fissure or upon the hanging wall adjacent to it. * * *.

In the Middle vein territory, at the extreme southwest end of the present workings, located under what is known as the Bonanza Flat region, the ore has been found to be extensive and is following the main faulting system on its strike toward the southwest end of the property.

Most of the ore of both milling and shipping grade was produced from the 900, 1,100, and 1,200 foot levels. The Daly vein produced 18,518 tons of milling ore and 197 tons of ore of shipping grade, the Middle vein 10,346 tons of milling ore and 384 tons of shipping ore, and the Back vein 8,717 tons of milling ore and 4,945 tons of ore of shipping grade—a total of 43,107 tons of ore mined in 1919, compared with 50,255 tons in 1918. Concentrates from 40,396 tons of ore amounted to 7,862 dry tons of lead concentrate and 5,281 tons of zinc concentrate. The ratio of concentration of lead concentrate was 5 to 1 and of the combined lead and zinc concentrates 3 to 1. The average content of the ore and concentrates in 1919 taken from the company report was as follows:

[31] Judge Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1919.

Kind of material.	Ore (dry).	Gold (per ton).	Silver (per ton).	Copper.	Lead.	Zinc.	Iron.	Price sold for.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ton.*
Crude ore with residue mixed	7,648	0.026	28.59	1.16	14.78	10.83	8.04	$32.04
Lead concentrate with residue mixed	7,862	.032	22.41	.58	29.94	9.68	17.40	42.90
Residue	719	.026	19.62	.90	6.46	11.07	.....	16.60
Zinc dross	142	.....	.....	.....	.....	89.00	.....	69.38
Spelter	505	.....	.....	.....	.....	99.90	.....	162.88

The total metallic output as given in the company report was 462.45 ounces of gold, 410,307 ounces of silver, 276,926 pounds of copper, 6,989,908 pounds of lead, and 1,262,760 pounds of zinc, valued in all at the selling price at $711,847.20. Dividends disbursed since incorporation amount to $2,370,000, including $60,000 paid in 1919.

Operations were curtailed at the Ontario mine [32] the first half of 1919 by the general labor strike in the camp and later by the shortage of efficient miners. However, it was necessary to keep the pumps in operation to prevent the mine from being flooded. This work was performed by the superintendent, shift bosses, and salaried men. Several bodies of ore were opened, the most promising of which was in the No. 8 raise on the 1,700-foot level. This ore body was followed to the 1,500-foot level. Development on the lower levels was encouraged by the management, and milling tests were under way for large bodies of low-grade material opened on the 1,600 and 1,700 foot levels. Ore sales amounted to $284,379.03 in 1919, and one dividend of $53,413.37 was paid.

TOOELE COUNTY.

Mine production in Tooele County, Utah, 1918–19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	51	102,305	$23,703	691,175	2,531,769	14,197,551	517,600	$2,395,353
1919	30	87,339	16,032	520,169	1,512,157	12,311,455	398,355	1,561,469
Decrease, 1919	21	14,966	7,671	171,006	1,019,612	1,886,096	119,245	833,884

The production of ore in Tooele County in 1918 and 1919 is shown in the accompanying table. The average value per ton of the ore decreased from $23.41 in 1918 to $17.88 in 1919, and the value per ton in gold and silver decreased from $6.99 to $6.85.

Crude shipping ore of various kinds amounted to 42,066 tons. The zinc ore produced was 825 tons, all of which was of shipping grade and an oxidized product. The quantity of dry or siliceous ore increased from 4,040 tons in 1918 to 13,338 tons in 1919. The output of copper ore of shipping grade was 1,341 tons, all of which was oxidized, and the lead ore was 25,409 tons, of which 6,030 tons was

[32] Ontario Silver Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

oxidized and 19,379 tons was sulphide. There was also 1,366 tons of copper-lead ore. The crude ore shipped directly to the smelters contained $13,938 in gold, 349,683 ounces of silver, 1,063,084 pounds of copper, 8,801,873 pounds of lead, and 398,355 pounds of recoverable zinc, having a total value of $1,098,896, or an average of $26.12 a ton. Concentrating and jigging plants produced 14,229 tons of concentrates from the treatment of 45,060 tons of ore and yielded $2,023 in gold, 167,608 ounces of silver, 447,695 pounds of copper, and 3,504,438 pounds of lead, valued in all at $458,750, or an average of $32.24 a ton.

Clifton district (*Gold Hill*).—Nine producers reported 14,257 tons of ore, containing $4,835 in gold, 53,706 ounces of silver, 194,476 pounds of copper, and 778,869 pounds of lead, valued in all at $142,439, or an average of $9.99 a ton. Operations were resumed at the Gold Hill property of the Western Utah Copper Co. in May. It was the principal producer of ore, the entire output of which was sold under contract to the smelting company at a flat rate regardless of the metal contents. The ore contains lead, silver, copper, and arsenic, the last named being recovered in the bag houses and flue chambers of the smelters to which the ore is shipped. The concentration mill of the company was operated a short time, and the scheelite concentrate from the treatment of copper-tungsten ore was stored on the expectation that the product would some day bring a better market price. On the 700-foot level of the Gold Hill mine the drift along the footwall of the vein, which has been developed from that level to the surface, has been driven a distance of 100 feet, all in low-grade ore.

Lead ore containing silver was also shipped from the Garrison Monster claims. Other producers of lead ore were the Midland and Southern Confederate properties, and the Monoco and Frankie claims yielded copper ores.

Dugway district.—Lead ore containing silver from the Laurel mine comprised the principal part of the Dugway district's output, made by four producers, and aggregating 83 tons in 1919.

Erickson district (*Indian Springs*).—Development work at the O. K. mine resulted in the production of a small lot of silver ore shipped directly to the smelter.

North Tintic district (*Lofgreen*).—Considerable zinc ore and some lead ore were shipped from the Scranton mine by lessees in 1919.

Ophir district.—Seven producers reported the mining of 66,567 tons of ore, the larger part of which was milled and yielded 14,212 tons of concentrate, containing lead, copper, and silver, with a little gold. The shipping ores aggregated 21,362 tons, containing 160.53 ounces of gold, 241,820 ounces of silver, 843,316 pounds of copper, and 4,877,869 pounds of lead. Some old tailing was also shipped from an old mill site. The total output of the district contained $5, 388 in gold, 412,292 ounces of silver, 1,290,464 pounds of copper, and 8,387,451 pounds of lead, valued in all at $1,151,716, or an average of $17.30 a ton. The principal producers were the Ophir Hill, Hidden Treasure, Montana, and Buffalo Consolidated properties.

Rush Valley district (*Stockton*).—All the ore mined in 1919 was of smelting grade, aggregating 4,913 tons and containing $5,713 in gold, 50,033 ounces of silver, 24,598 pounds of copper, 2,676,501 pounds of lead, and 70,698 pounds of zinc, valued in all at $213,340, or an aver-

age of $43.43 a ton. The Bullion Coalition, operated by lessees, was the largest producer of lead ore, which contained silver, copper, and a little gold. The Calumet, Galena King, Muerbrook, Cyclone, and Southport claims shipped lead ore containing silver.

Wild Cat Range district.—From the Silver Queen property some copper ore, containing silver and considerable high-grade fluorite, was shipped; the fluorite went to steel works in California and Utah.

UINTA COUNTY.

Although no production of ore or bullion was reported from mines in Uinta County, there was some prospecting of the Green River sands for gold, for which the Homestake Gold Placer Mining Co. was organized.

UTAH COUNTY.

Thirteen operators in Utah County reported the production of 64,281 tons of ore in 1919, against 71,021 tons in 1918, produced by 15 operators. The total value of the output in 1919 was $2,776,424, against $2,439,585 in 1918. The total average value per ton of the ore increased from $34.35 in 1918 to $43.19 in 1919, and the gold and silver value per ton increased from $25.15 to $35.38. Most of the ore produced (52,733 tons) was of shipping grade, and the remainder (11,548 tons), containing gold, silver, copper, was treated at the Silver City mill.

American Fork district.—The average value of ore produced in the American Fork district in 1919 was $50.17 a ton, compared with $11.83 in 1918. All the ore produced in 1919 was shipped directly to the smelters. The Blue Rock (Pacific) mine, under lease to the Fissures Exploration Co., was operated between May 16 and August 30, but no ore was shipped. The Exploration Co. was thrown into involuntary bankruptcy in July by its creditors. The owners of the mine continued development in parts of the mine not opened by lessees.

Mine production in American Fork district, Utah, 1918–19.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	6	11,875	$961	34,865	14,951	1,421,790	.....	$140,466
1919	4	116	934	1,583	3,649	45,917	.....	5,820
Decrease, 1919	2	11,759	27	33,282	11,302	1,375,873	.....	134,646
Total 1870-1919	.....	76,208	273,268	1,924,044	177,691	30,054,503	46,911	4,041,336

North Tintic district.—The Lehi Tintic mine produced a small quantity of lead ore. Developments disclosed some ore on the 900-foot level, which was opened fron the lower tunnel adit on the property.

Tintic district.—The Tintic Standard mine and the Colorado Consolidated were the two principal producers of ore, in the Tintic district, followed by the Four Aces, May Day, Uncle Sam, Utah group, and Yankee properties, whose output is included in the tables given under Juab County.

WASHINGTON COUNTY.

Harrisburg district.—With higher prices for silver the old tailing dumps and some of the famous producers of the Harrisburg district have been consolidated. Tests on the ores from the different mines and also the tailing dumps were started on a small scale in December, 1917, and between that time and the end of 1919 very successful tests were reported to the mine owners from the laboratories of the United States Bureau of Mines at Salt Lake City, where the chloridizing volatilization process in connection with the Cottrell precipitator is in use.

Four mining companies were at work in the district—on the Christy and Leeds properties, operated by San Francisco interests, and on the Barbee, Walker, and Stormont mines, under control of eastern capitalists. The Kinner mine, on the Buckeye Reef, and a few claims in the southern part of the White Reef were prospected. Little work was done in 1919 on the Silver Reef, as the east branch of the White Reef's horseshoe is locally known.

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GOLD, SILVER, COPPER, LEAD, AND ZINC IN IDAHO.

(MINES REPORT.)

By C. N. Gerry.[1]

PRODUCTION.

GENERAL STATEMENT.

The value of the mine production of gold, silver, copper, lead, and zinc in Idaho in 1919 decreased nearly 50 per cent from the value of 1918. The output of all metals except gold and the quantity of ore sold or treated decreased considerably. The decrease in the value of the output was unusually large, as a labor strike in the Coeur d'Alene district prevented shipments for several months, and the average prices of copper, lead, and zinc were much lower than those of 1918. Only silver increased in price—to $1.12 an ounce. For these reasons, and on account of high costs, mining conditions in general were discouraging. Dividends for 1919 amounted to $2,558,866, exclusive of those of the Hercules Mining Co., which are not published.

The production of the State from the discovery of placer gold to the end of 1919 is given in the table below. The total to 1914, inclusive, has been previously given by periods.[2] The complete table shows that the State has been an important producer of the five metals, which have a total value of $672,459,678. Lead represents $310,599,382; silver, $168,200,725; gold, $132,327,023; copper, $21,756,135; and zinc, $39,576,413.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	301	2,091,619	$702,816	9,172,340	6,533,888	294,695,993	45,161,712	$36,522,158
1919	210	1,457,395	713,238	5,579,056	3,122,763	182,341,898	15,994,229	18,374,315
Increase or decrease, 1919	−91	−634,224	+10,422	−3,593,284	−3,411,125	−112,354,095	−29,167,483	−18,147,843
Total, 1863–1919	.....	.....	132,327,023	239,457,351	126,021,580	6,248,386,143	402,374,581	672,459,678

[1] The work of tabulating the figures and compiling the tables used in this report was done by B. N. Patchell, of the United States Geological Survey.

[2] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 958, 1915.

The table giving the production of metals according to source shows a distinct decrease in gold from placers but an increase from siliceo is ore. The other metals decreased generally from all sources, but the decrease in silver and lead from lead ore was most pronounced.

Ore and metals produced in Idaho in 1919.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	72	.....	9,227.63	1,902	.....	.....	.....
Dry or siliceous ore	51	48,251	22,262.08	78,531	11,976	6,455	.....
Copper ore	16	51,546	962.13	246,983	2,545,044	.....	.....
Lead ore	73	1,149,951	1,970.50	4,757,259	564,415	160,572,291	.....
Zinc ore	3	1,478	.....	862	.....	60,779	1,233,336
Copper-lead ore	1	19	.58	492	1,328	5,604	.....
Lead-zinc ore	3	206,750	79.97	493,027	.....	21,696,769	14,760,893
	.....	1,457,395	34,502.89	5,579,056	3,122,763	182,341,898	15,994,229

ORE.

The quantity of ore sold or treated in Idaho in 1919 decreased about 30 per cent compared with 1918. Most of the output was lead ore (nearly 79 per cent) and lead zinc (more than 14 per cent); copper ore represented nearly 4 per cent, siliceous ore more than 3 per cent, and zinc ore and copper-lead ore about 1 per cent. Many of the concentration mills in the Coeur d'Alene region make a separate zinc product which is shipped to a zinc smelter or electrolytic plant, but this product continued to decrease in 1919. The total ore mined and treated had an average value per ton in gold and silver of $4.64. The average values in gold and silver for each kind of ore are shown at the foot of the following table. The siliceous ore sold or treated averaged per ton as follows: Gold, $9.54; silver, 1.63 ounces; copper and lead, trace. The siliceous ore included 44,537 tons of gold ore, averaging per ton $1.02 in gold and 0.30 ounce of silver; and 3,693 tons of silver ore, averaging per ton $1.44 in gold, 17.29 ounces of silver, 2.55 pounds of copper, and 1.50 pounds of lead. The copper ore averaged 39 cents in gold and 4.79 ounces of silver per ton and contained 2.47 per cent of copper. Most of the siliceous ore was treated by amalgamation or cyanidation, and most of the copper ore was concentrated. The averages of the crude shipping product are given later. Lead ore as mined averaged 4 cents in gold and 4.14 ounces of silver per ton and contained less than 0.03 per cent of copper and 6.98 per cent of lead. The total zinc ore mined or treated averaged 0.58 ounce of silver per ton and contained 2.06 per cent of lead and 41.72 per cent of recoverable zinc. Copper-lead ore, only 19 tons, averaged 63 cents in gold and 25.90 ounces of silver per ton and contained 3.50 per cent of copper and 14.75 per cent of lead. Lead-zinc ore averaged 2.39 ounces of silver per ton and contained a trace of copper, 5.26 per cent of lead, and 3.58 per cent of recoverable zinc. Most of the lead ore and lead-zinc ore was milled, and the results are stated in the text following the table on concentrates.

Ore sold or treated in 1919, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Adams		78					78
Blaine	3		24,011		19		24,033
Boise	40,806	24					40,830
Bonner	32		144				176
Boundary			44,549				44,549
Butte			276				276
Camas	2		11				13
Cassia			360				360
Clearwater	2						2
Custer	57	13,504	1,980				15,541
Elmore	319						319
Fremont		37					37
Gem	487						487
Idaho	1,084						1,084
Latah		38					38
Lemhi	2,333	447	14,790				17,570
Owyhee	2,703						2,703
Shoshone	423	36,182	1,063,830	1,478		206,150	1,308,063
Washington		1,236					1,236
	[a] 48,251	51,546	1,149,951	1,478	19	206,150	1,457,395
Average value per ton in gold and silver	$11.36	$5.75	$4.67	$0.65	$29.63	$2.69	$4.64

[a] Includes 44,537 tons of gold ore, 21 tons of gold and silver ore, and 3,693 tons of silver ore.

About 3 per cent of the ore (40,844 tons) was treated in gold and silver mills in 1919, 1 ton less than in 1918. Bullion from this ore treated by amalgamation and cyanidation was valued at $327,421, or $8.02 a ton. Nearly all the bullion was obtained from mines in Boise County, and the increase in the total gold of the State was also attributable to Boise County. The output of gold bullion from Idaho County was much less, as the Holte mine, at Burgdorf, was unproductive. The expense of mining and the fact that most of the gold mines are far from a railroad prevented the operation of several properties formerly productive. Nearly all the gold in bullion was won by amalgamation, less than 1 per cent being recovered by cyanidation. At these mills during 1919, 828 pounds of mercury and 950 pounds of sodium cyanide were used. The average consumption of quicksilver was 0.0204 pound per ton of ore amalgamated and 0.0406 pound per ounce of gold and silver bullion saved. The cyanide consumption was 1.05 pounds per ton of ore treated and 2.07 pounds per ounce of gold and silver bullion recovered.

Gold and silver produced in mills in Idaho in 1919.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Boise	[a] 39,871	15,049.37	3,381			$314,885
Camas	2	2.13	1			45
Clearwater	2	1.03				21
Custer	16	12.91	5			273
Elmore	301	.24		58.82	28	1,252
Idaho	462	274.68	139	[b] 64.56	[b] 306	7,511
Lemhi	121	56.45	15			1,184
Owyhee	69	33.56	1,389			2,250
	40,844	15,430.37	4,930	123.38	334	327,421

[a] Also yielded 1,677 tons of concentrates. [b] Includes bullion from 567 tons of old tailings.

More than 80 per cent of the ore was concentrated. Concentrates from this ore, from 155,483 tons of old tailings treated, and from a small quantity of ore treated in gold and silver mills, aggregating 196,811 tons were valued at $69.99 a ton in 1919, against $82.64 in 1918. The concentrates were largely from the Coeur d'Alene region, and the ratio was 6.79 tons of ore and tailings to 1 ton of concentrate. More than 88 per cent of the total was lead concentrate, nearly 8 per cent zinc concentrate, less than 2 per cent lead-zinc concentrate, and the remainder copper concentrate and siliceous concentrate. The decrease, amounting to 120,075 tons, was principally in the lead and lead-zinc products. Operators in Shoshone County shipped an average of 15,467 tons of concentrates of various kinds per month, against 25,670 tons in 1918. This with the crude ore shipped, which was 4,056 tons a month, gives the Coeur d'Alene region an average monthly output of 19,523 tons of concentrates and crude ore, against 34,762 tons in 1918.

Mine production of metals from Idaho concentrates in 1919.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						
		Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Blaine	13,126	4,230	500.50	206,326	7,204	1,467,095	.....	$320,527
Boise	932	1,910	4,917.50	9,605	1,673	908	.....	112,771
Bonner	144	37	.....	518	.....	56,514	.....	3,575
Boundary	44,460	4,544	32.27	99,849	.....	5,620,739	.....	410,398
Camas	2	1	.20	8	7	305	.....	30
Cassia	360	60	79.27	1,082	1,210	33,925	.....	4,874
Lemhi	5,555	396	201.86	7,401	.....	225,000	.....	24,387
Owyhee	2,616	33	156.46	25,237	53	102	.....	31,514
Shoshone	1,103,907	185,600	813.04	3,622,390	981,905	142,125,302	14,760,893	12,866,705
	1,171,102	196,811	6,701.10	3,972,416	992,052	149,529,890	14,760,893	13,774,781

By kinds of concentrates.

Dry or siliceous	.....	1,972	5,275.82	34,903	1,726	1,010	.....	$148,527
Copper	.....	2,444	95.77	99,436	714,790	.....	.....	246,299
Lead	.....	173,843	1,329.51	3,783,633	275,536	147,926,144	.....	12,156,488
Zinc	.....	15,360	.....	29,244	.....	1,257,736	12,418,293	1,005,948
Lead-zinc	.....	3,192	.....	25,200	.....	345,000	2,342,600	217,519

The concentrates had the following average contents: Siliceous concentrates contained $55.31 in gold and 17.70 ounces of silver, and had a value of $75.32 a ton for all metals. Copper concentrates contained 81 cents in gold and 40.69 ounces of silver per ton and 14.62 per cent of copper, a total value of $100.78 a ton. Lead concentrates averaged 16 cents in gold and 21.77 ounces of silver per ton, 0.08 per cent of copper, and 42.55 per cent of lead, or a total value of $69.93 a ton. Zinc concentrates averaged 1.90 ounces of silver per ton, 4.09 per cent of lead, and 40.42 per cent of recoverable zinc, or a total value of $65.49 a ton. Lead-zinc concentrates averaged 7.90 ounces of silver per ton, 5.40 per cent of lead, and 36.70 per cent of recoverable zinc, or a total value of $68.15 a ton. Averages for

concentrates, as well as for shipping ore, from 1911 to 1914 were given in a previous report.[3]

Of the total ore, more than 5 per cent was shipped crude to smelters, a decrease from 186,551 tons in 1918. The decrease was large in Shoshone and Custer counties. Prior to 1917 most of the crude ore and concentrate was shipped outside the State for smelting. In 1918 and 1919 the Bunker Hill smelter, at Bradley, treated a large part of the lead products and considerably enlarged its plant. The total value of the first-class ore was $4,079,231, or $51.38 a ton. The decrease was large in both copper ore and lead ore. Nearly 73 per cent of the crude ore shipped was lead ore, more than 21 per cent was copper ore, nearly 4 per cent was siliceous ore, and nearly 2 per cent was zinc ore. The combined value of the concentrates and crude ore shipped was $17,854,012. The ore smelted was principally sulphide ore. A close separation of oxidized and sulphide portions, with average content per ton, is as follows: Copper ore shipped consisted of 8,747 tons of oxidized and carbonate ore, averaging $1.32 in gold and 2.12 ounces of silver per ton and 5.80 per cent of copper, or a total value of $25.26 a ton; and of 8,115 tons of sulphide ore averaging 83 cents in gold and 14.90 ounces of silver per ton and 5.08 per cent of copper, or a total value of $36.42 a ton. There was a greater difference in the lead ore, for the oxidized portion (11,637 tons) averaged 81 cents in gold and 14.44 ounces of silver per ton, 0.24 per cent of copper, and 27.78 per cent of lead, or a total value of $42.34 a ton; and the sulphide lead ore shipped (46,261 tons) averaged 12 cents in gold and 26.89 ounces of silver per ton, 0.25 per cent of copper, and 28.40 per cent of lead, or a total value of $61.28 a ton. All the crude zinc ore shipped was sulphide. One shipment of copper-lead ore was sulphide.

Mine production of metals from Idaho crude ore shipped to smelters in 1919.

By counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Adams	78	.40	362	26,993			$5,435
Blaine	907	139.04	66,953	11,439	690,205		116,570
Boise	27	4.40	1,824	1,535	107		2,426
Bonner	32	.60	675				768
Boundary	89	.67	1,715		92,854		6,855
Butte	276	3.03	3,742	995	93,619		9,401
Camas	9	.50	819	73	4,408		1,175
Custer	15,525	722.34	102,358	1,352,487	936,898		430,792
Elmore	18	1.56	691				806
Fremont	37		30	10,315			1,953
Gem	487	54.08	18,352	960	1,720		21,941
Idaho	55	54.49	83	867			1,381
Latah	38	1.13	38	12,338			2,361
Lemhi	11,894	1,719.83	127,374	156,610	5,450,557		496,220
Owyhee	18	12.00	1,250				1,648
Shoshone	48,673	306.34	1,191,275	492,737	25,541,630	1,233,336	2,875,949
Washington	1,236		81,933	63,362			103,550
	79,399	3,020.41	1,599,474	2,130,711	32,812,908	1,233,336	4,079,231

By kinds of ore.

Dry or siliceous	3,142	1,432.48	38,364	10,250	5,445		$74,776
Copper	16,862	866.35	147,547	1,830,254			523,588
Lead	57,898	721.00	1,412,209	288,879	32,740,180		3,385,539
Zinc	1,478		862		60,779	1,233,336	94,221
Copper-lead	19	.58	492	1,328	5,604		1,107

[3] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 601, 1915.

The crude ore shipped had the following averages: Siliceous ore averaged $9.43 in gold and 12.21 ounces of silver per ton, 0.16 per cent of copper, and 0.09 per cent of lead, or a total value of $23.80 a ton. Copper ore averaged $1.06 in gold and 8.75 ounces of silver per ton and 5.43 per cent of copper, or a total value of $31.05 a ton. Lead ore averaged 3 cents in gold and 24.39 ounces of silver per ton, 0.25 per cent of copper, and 28.27 per cent of lead, or a total value of $58.47 a ton. The crude zinc ore averaged 0.58 ounce of silver per ton, 2.06 per cent of lead, and 41.72 per cent of recoverable zinc, or a total value of $63.75 a ton. Copper-lead ore smelted averaged 63 cents in gold and 25.90 ounces of silver per ton, 3.50 per cent of copper, and 14.75 per cent of lead, or a total value of $58.26 a ton.

GOLD.

The mine production of gold in Idaho in 1919 was valued at $713,238, an increase of 1.5 per cent. The mines of Boise County had the largest output of gold, and Shoshone County was second on account of the operations of the dredge at Murray. A large increase in Boise County balanced decreases in Idaho, Shoshone, and Custer counties. The lode mines, 138 in number, produced gold valued at $522,486; 72 placers produced gold valued at $190,752, against 85 placers and $276,410 in 1918. Of the placer gold, $164,854 was won by dredges and $25,898 by hydraulic or sluicing mines. No drift mining was reported. The output by dredges in 1919 decreased $74,908 from that of 1918, and gold recovered by sluicing and hydraulicking decreased $10,732. Of the total gold, nearly 27 per cent came placers, nearly 65 per cent from siliceous ore, about 6 per cent from lead ore, and nearly 3 per cent from copper ore. Siliceous ores contained $9.54 a ton in gold; copper ore, 39 cents; lead ore, 4 cents; and copper-lead ore, 63 cents. Snake River produced only $463 in gold, against $1,218 in 1918. The production of gold from amalgamation and cyanidation mills increased considerably over that of 1918. In 1919 bullion recovered in these mills contained 15,553.75 ounces of gold, or 45 per cent of the total, against 10,379.22 ounces in 1918. Amalgamation won 15,430.37 ounces of gold and cyanidation 123.38 ounces. Concentrates of all kinds contained only 6,701.10 ounces of gold, or about 19 per cent of the total gold, and crude ore shipped to smelters contained 3,020.41 ounces of gold, or nearly 9 per cent of the total. Sulphide shipping ores contained 612.96 ounces of gold, and oxidized ores contained 2,407.45 ounces. A statement of dredges operated since 1897 and their output by years was given in a former report.[4] A total of $4,186,119 has been recovered by dredges.

In 1919 only three mines had a gold output of more than $25,000 each—the Gold Hill & Iowa Mines Co., at Quartzburg; the Yukon Gold Co., at Murray; and the Gilmore Mining Co., at Gilmore. The Empire Copper Co., at Mackay, and the Independence mine, at Ketchum, also produced much gold.

[4] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 604, 1915.

Mine production of gold in Idaho in 1919, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	11.71						11.71
Adams			0.39				.39
Benewah	116.58						116.58
Blaine				638.94	0.58		639.52
Boise	271.24	19,966.87	4.41				20,242.52
Bonner		.58					.58
Bonneville	112.86						112.86
Boundary				32.94			32.94
Butte				3.05			3.05
Camas		2.15		.70			2.85
Cassia				79.29			79.29
Clearwater	567.20	1.06					568.26
Custer	4.50	13.33	678.29	43.63			739.75
Elmore	42.62	60.61					103.23
Gem		54.08					54.08
Idaho	238.05	393.73					631.78
Latah	21.87		1.11				22.98
Lemhi	164.81	1,564.75	2.46	410.94			2,142.96
Owyhee	5.85	202.02					207.87
Shoshone	7,567.93	2.90	275.47	761.01		79.97	8,687.28
Twin Falls	2.47						2.47
Valley	99.94						99.94
	9,227.63	[a] 22,262.08	962.13	1,970.50	.58	79.97	34,502.89

[a] Includes 21,989.06 ounces from gold ore, 15.94 ounces from gold and silver ore, and 257.08 ounces from silver ore.

SILVER.

The mine production of silver in Idaho in 1919 decreased more than 39 per cent in quantity, but only about 32 per cent in value. The output of Washington, Blaine, and Boundary counties increased slightly, but that of Shoshone County decreased 3,632,019 ounces. A separation of the silver according to source shows that the largest part of the total silver yield, or more than 85 per cent, was from lead ore, nearly 9 per cent from lead-zinc ore, more than 4 per cent from copper ore, and less than 2 per cent from siliceous ore, zinc ore, copper-lead ore, and placers. Shoshone County produced more than 86 per cent of the silver. Concentrates supplied more than 71 per cent of the silver, shipping ore contained nearly 29 per cent, and gold and silver bullion contained only 0.10 per cent. Crude shipping ore averaged 20.14 ounces of silver a ton and concentrates 20.18 ounces a ton. The silver contents of the different kinds of shipping ore have already been given. The Zula Pearl mine, in Gem County, and the Florida Mountain property, in Owyhee County, produced a fair quantity of silver ore. Much silver ore was formerly produced in Owyhee County.

Ten mines in Idaho produced a total of 4,669,132 ounces of silver in 1919, or nearly 84 per cent of the total; they were the Bunker Hill, Hecla, Hercules, Caledonia, Morning, Tamarack & Custer, Gold Hunter, Independence, Consolidated Interstate-Callahan, and Idaho Continental mines. Each of these produced more than 100,000 ounces of silver, and four of them produced more than 500,000 ounces.

Mine production of silver in Idaho in 1919, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Ada	3							3
Adams			362					362
Benewah	12							12
Blaine		219		272,568		492		273,279
Boise	73	13,445	1,365					14,883
Bonner		675		518				1,193
Bonneville	3							3
Boundary				101,564				101,564
Butte				3,742				3,742
Camas		1		827				828
Cassia				1,082				1,082
Clearwater	138							138
Custer	3	755	61,575	40,033				102,366
Elmore	8	719						727
Fremont			30					30
Gem		18,352						18,352
Idaho	42	528						570
Latah	1		38					39
Lemhi	22	1,867	251	132,672				134,812
Owyhee	4	27,876						27,880
Shoshone	1,535	14,094	101,429	4,204,253	862		493,027	4,815,200
Valley	58							58
Washington			81,933					81,933
	1,902	[a] 78,531	246,983	4,757,259	862	492	493,027	5,579,056

[a] Includes 13,447 ounces from gold ore, 244 ounces from gold and silver ore, and 64,840 ounces from silver ore.

COPPER.

The mine production of copper in Idaho in 1919 decreased more than 52 per cent in quantity and about 64 per cent in value. Nearly half of the copper came from Shoshone County, and about 43 per cent from Custer County. The Empire property, near Mackay, is still the largest copper producer in the State. In the Coeur d'Alene region the National and Richmond mines produced much copper, though the National was closed early in the year. More than 81 per cent of the total output was from copper ore, about 18 per cent from lead ore, and less than 1 per cent from copper-lead and siliceous ores. Crude shipping ore of all kinds contained more than 68 per cent of the copper, and concentrates nearly 32 per cent. Crude copper ore of shipping grade averaged 5.43 per cent of copper, and copper concentrates 14.62 per cent. Smelting sulphide ore contained 5.08 per cent of copper, and oxidized ore 5.80 per cent. The average price of copper decreased from 24.7 cents a pound in 1918 to 18.6 cents in 1919. The following five mines produced more than 50,000 pounds each and a total of more than 2,500,000 pounds: Empire, National, Richmond, Caledonia, and Harmony.

Mine production of copper in Idaho in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Adams		26,993			26,993
Blaine			17,315	1,328	18,643
Boise	1,719	1,489			3,208
Butte			995		995
Camas			80		80
Cassia			1,210		1,210
Custer	253	1,344,673	7,561		1,352,487
Fremont		10,315			10,315
Gem	960				960
Idaho	867				867
Latah		12,338			12,338
Lemhi	58	108,745	47,807		156,610
Owyhee	53				53
Shoshone	8,066	977,129	489,447		1,474,642
Washington		63,362			63,362
	[a] 11,976	2,545,044	564,415	1,328	3,122,763

[a] Includes 2,540 pounds from gold ore, 24 pounds from gold and silver ore, and 9,412 pounds from silver ore.

LEAD.

The mine production of lead in Idaho in 1919 decreased more than 38 per cent in quantity and nearly 54 per cent in value. The output of 1917 was a record for the State and was close to that of Missouri, the leading lead producer of the United States. The value of the output of lead in 1919 was greater than the combined value of the output of gold, silver, copper, and zinc. Shoshone County supplied nearly 92 per cent of the total output, but a good production was made by Boundary, Lemhi, and Blaine counties. Lead ore supplied more than 88 per cent of the total and lead-zinc ore nearly 12 per cent. The recoverable lead in lead ores sold or treated averaged 6.98 per cent, and that in lead-zinc ore 5.26 per cent. Crude lead ore of shipping grade averaged 28.27 per cent of recoverable lead, and lead concentrates 42.55 per cent. Concentrates of all kinds produced 82 per cent of the total, and lead concentrates had an average value of $69.93 a ton. Crude ore shipped was the source of nearly 18 per cent of the lead, and the lead ore shipped to smelter had an average value of $58.47 a ton. Most of the lead in crude ore shipped was derived from sulphide ores, only 6,466,354 pounds coming from oxidized ores. The average price of lead for 1919 was 5.3 cents a pound, a decrease of 1.8 cents from the price in 1918.

Fifteen mines produced more than 97 per cent of the State output of lead in 1919. These were the Bunker Hill, Hecla, Morning, Hercules, Tamarack & Custer, Gold Hunter, Consolidated Interstate-Callahan, Idaho Continental, Caledonia, Pittsburg-Idaho, Sierra Nevada, Latest Out, Independence, Mace, and Frisco mines. Each one produced more than 1,000,000 pounds of lead, and the first four produced more than 15,000,000 pounds.

Mine production of lead in Idaho in 1919, in pounds.

County.	Dry or siliceous ore.	Lead ore.	Zinc ore.	Copper-lead ore.	Lead-zinc ore.	Total.
Blaine		2,151,696		5,604		2,157,300
Boise	1,015					1,015
Bonner		56,514				56,514
Boundary		5,713,593				5,713,593
Butte		93,619				93,619
Camas		4,713				4,713
Cassia		33,925				33,925
Custer	3,495	933,403				936,898
Gem	1,720					1,720
Lemhi	123	5,675,444				5,675,567
Owyhee	102					102
Shoshone		145,909,384	60,779		21,696,769	167,666,932
	[a] 6,455	160,572,291	60,779	5,604	21,696,769	182,341,898

[a] Includes 908 pounds from gold ore and 5,547 pounds from gold and silver ore.

ZINC.

The mine production of recoverable zinc in Idaho in 1919 decreased about 65 per cent in quantity and nearly 72 per cent in value. The decrease of 29,167,483 pounds in quantity and of $2,942,137 in value was almost wholly in the Coeur d'Alene region. The Consolidated Interstate-Callahan property retained first place among the zinc producers of the State, though its output was greatly decreased. No shipments of zinc carbonate ore or sulphide concentrate were made from Blaine County. Though the output of zinc in the State has decreased since 1917, it is still more valuable than the output of either gold or copper. Lead-zinc ore supplied more than 92 per cent of the zinc, and zinc ore nearly 8 per cent. Both the zinc concentrates and the crude zinc ore shipped are sulphide products. From concentrates, both zinc and lead-zinc, 14,760,893 pounds of recoverable zinc was obtained, and from crude ore shipped, 1,233,336 pounds. Flotation is used extensively in the treatment of zinc ore and especially in the retreatment of old tailings containing zinc and lead. Nearly all the zinc material was smelted in eastern plants in 1919, though the freight rate was high. The average price of metallic zinc was 7.3 cents a pound in 1919, 1.8 cents less than the price in 1918.

Four mines—the Consolidated Interstate-Callahan, Morning, Success, and Frisco—produced more than 300,000 pounds of recoverable zinc each in 1919.

Shipments of zinc ore, zinc concentrates, and lead-zinc concentrates amounted to 20,030 tons, of which the gross content was 18,817,761 pounds of zinc, or an average of 46.97 per cent. All the output came from the Beaver, Hunter, Lelande, Placer Center, and Yreka districts, in Shoshone County. In 1918 the shipments were 59,336 tons of zinc ore and concentrates containing 51,988,862 pounds of zinc, or an average of 43.81 per cent.

REDUCTION PLANTS.

In Idaho 40 milling plants of all kinds were in operation in 1919, against 62 active mills in 1918. Of these mills 26 were concentration plants, 13 of which used flotation machines with other concentrating devices, 2 used flotation alone, and 11 used crushers, jigs, and tables without flotation cells; 10 used amalgamation alone; 2 used cyanida-

tion; 1 used amalgamation and concentration; and 1 used amalgamation and cyanidation. Several concentration plants were under construction, and one plant, which uses a volatilization process on copper ore, was completed in Lemhi County. Much of the ore and concentrate from Shoshone County is now smelted at Bradley, Idaho, instead of being shipped to distant plants.

MINING INDUSTRY.

The decrease of nearly 50 per cent in the value of the metal output of Idaho in 1919, following a decrease of 33 per cent in 1918, indicates that the mines were affected by conditions more serious than the prevailing high costs. Abnormal expenses continued, metal prices were lower, except silver, and in the early part of the year the market for lead, the most abundant metal produced in Idaho, was decidedly poor. As a result of these adverse conditions, several of the large producing mines were closed. When, later in the year, the demand for lead was better and operations were resumed, the men in the Coeur d'Alene region struck for higher wages and recognition of the union, which closed nearly all the mines for two months. After the strike was declared off it was difficult to resume operations, as many of the miners had left the district when the trouble began. The output of the Hercules and Tamarack & Custer mines was only half that of 1918, and the lead smelter at Northport, Wash., was forced to close during the greater part of the year. Fortunately, the men at the Bunker Hill mine and smelter remained at work, and this famous producer was operated the entire year. Many of the mines in isolated districts made no effort to mine ore or pursue development work while expenses were so great.

Mine production of gold, silver, copper, lead, and zinc in Idaho in 1919.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Ada	11.71	$242			$242	3	$3
Adams			0.39	$8	8	362	406
Benewah	116.58	2,410			2,410	12	13
Blaine			639.52	13,220	13,220	273,279	306,073
Boise	271.24	5,607	19,971.28	412,843	418,450	14,883	16,669
Bonner			.58	12	12	1,193	1,336
Bonneville	112.86	2,333			2,333	3	3
Boundary			32.94	681	681	101,564	113,752
Butte			3.05	63	63	3,742	4,191
Camas			2.85	59	59	828	927
Cassia			79.29	1,639	1,639	1,082	1,212
Clearwater	567.20	11,725	1.06	22	11,747	138	155
Custer	4.50	93	735.25	15,199	15,292	102,366	114,650
Elmore	42.62	881	60.61	1,253	2,134	727	814
Fremont						30	34
Gem			54.08	1,118	1,118	18,352	20,554
Idaho	238.05	4,921	393.73	8,139	13,060	570	638
Latah	21.87	452	1.11	23	475	39	44
Lemhi	164.81	3,407	1,978.15	40,892	44,299	134,812	150,989
Owyhee	5.85	121	202.02	4,176	4,297	27,880	31,226
Shoshone	7,567.93	156,443	1,119.35	23,139	179,582	4,815,200	5,393,024
Twin Falls	2.47	51			51		
Valley	99.94	2,066			2,066	58	65
Washington						81,933	91,765
	9,227.63	190,752	25,275.26	522,486	713,238	5,579,056	6,248,543

Mine production of gold, copper, lead, and zinc in Idaho in 1919—Continued.

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Ada							$245
Adams	26,993	$5,021					5,435
Benewah							2,423
Blaine	18,643	3,468	2,157,300	$114,337			437,098
Boise	3,208	597	1,015	54			435,770
Bonner			56,514	2,995			4,343
Bonneville							2,336
Boundary			5,713,593	302,821			417,254
Butte	995	185	93,619	4,962			9,401
Camas	80	15	4,713	250			1,251
Cassia	1,210	225	33,925	1,798			4,874
Clearwater							11,902
Custer	1,352,487	251,563	936,898	49,656			431,161
Elmore							2,948
Fremont	10,315	1,919					1,953
Gem	960	178	1,720	91			21,941
Idaho	867	161					13,859
Latah	12,338	2,295					2,814
Lemhi	156,610	29,129	5,675,567	300,805			525,222
Owyhee	53	10	102	5			35,538
Shoshone	1,474,642	274,283	167,666,932	8,886,347	15,994,229	$1,167,579	15,900,815
Twin Falls							51
Valley							2,131
Washington	63,362	11,785					103,550
	3,122,763	580,834	182,341,898	9,664,121	15,994,229	1,167,579	18,374,315

Though the value of the metal output was only about half that of 1918, the gold increased slightly. Gold from deep mines increased sufficiently to offset the decrease of more than 4,000 ounces in gold from placers.

Producing placer mines and production of gold and silver in Idaho in 1918 and 1919.

County.	1918						1919				
	Mines.			Gold.	Silver.	Total value.	Mines.		Gold.	Silver.	Total value.
	Hydraulic.	Dredge.	Drift.				Hydraulic.	Dredge.			
					Fine ounces.					*Fine ounces.*	
Ada	2			$972	9	$981	1		$242	3	$245
Adams	1			376	4	380					
Benewah	1			704	3	707	1		2,410	12	2,423
Bingham	1			49		49					
Blaine	1			56		56					
Boise	18	1		51,538	692	52,230	12		5,607	73	5,689
Bonneville	1			2,239	3	2,242	2		2,333	3	2,336
Clearwater	9	1		4,527	70	4,597	5	1	11,725	138	11,880
Custer	5			1,040	56	1,096	1		93	3	96
Elmore	4			1,183	12	1,195	4		881	8	890
Fremont	1			16		16					
Idaho	15		1	4,794	42	4,836	24		4,921	42	4,968
Latah							2		452	1	453
Lemhi	4	2	1	17,297	199	17,496	7	1	3,407	22	3,432
Nez Perce	1			133	1	134					
Owyhee	2			52	1	53	1		121	4	126
Power	2			215		215					
Shoshone	4	1		186,354	2,047	188,401	4	1	156,443	1,535	158,162
Twin Falls	3			303	3	306	2		51		51
Valley	3			4,562	141	4,703	3		2,066	58	2,131
	78	5	2	276,410	3,283	279,693	69	3	190,752	1,902	192,882

The decrease in placer gold from Boise and Lemhi counties resulted from the exhaustion of ground formerly worked by dredges.

Ores sold or treated, deep mines producing, and average value of ores in Idaho in 1918 and 1919.

County.	Ore sold or treated in 1919.		Number of deep mines producing.		Average total value per ton.		Average value per ton in gold and silver.	
	Quantity.	Increase or decrease.	1918	1919	1918	1919	1918	1919
	Short tons.	*Short tons.*						
Ada		− 15	1	.....	$16.20	.....	$16.20	.....
Adams	78	− 91	3	1	62.13	$69.68	1.77	$5.31
Blaine	24,033	+ 333	34	16	22.99	18.19	10.19	13.29
Boise	40,830	+ 16,119	10	12	8.38	10.53	8.26	10.52
Bonner	176	− 606	2	2	21.68	24.68	2.94	7.66
Boundary	44,549	+ 16,576	2	1	13.94	9.37	2.76	2.57
Butte	276	− 939	2	1	42.61	34.06	7.05	15.41
Camas	13	− 627	5	4	12.85	96.23	11.73	75.85
Cassia	360	+ 72	3	1	12.12	13.54	3.94	7.92
Clearwater	2	− 35	2	1	8.73	11.00	8.73	11.00
Custer	15,541	− 46,758	27	19	21.53	27.74	4.01	8.36
Elmore	319	− 951	4	4	7.99	6.45	7.99	6.45
Fremont	37	− 101	1	1	42.34	52.78	.63	.92
Gem	487	+ 458	2	4	77.14	45.05	71.69	44.50
Idaho	1,084	− 14,483	22	9	5.27	8.20	5.27	8.05
Latah	38	− 129	1	1	118.77	62.13	1.87	1.74
Lemhi	17,570	+ 5,317	32	20	46.77	29.70	13.07	10.92
Owyhee	2,703	+ 516	12	6	18.17	13.10	18.03	13.10
Shoshone	1,308,063	−609,989	47	33	17.17	12.04	4.43	4.14
Valley	.....	− 22	2	.....	31.82	.....	31.36	.....
Washington	1,236	+ 1,131	2	2	60.50	83.78	28.29	74.24
	1,457,395	−634,224	216	138	17.33	12.48	4.59	4.64

The ore mined and sold or treated decreased more than 600,000 tons in both 1918 and 1919, and 78 deep mines active in 1918 were idle or unproductive in 1919.

REVIEW BY COUNTIES.

ADA COUNTY.

Only a small output, valued at $245, came from placer property in the Highland district.

ADAMS COUNTY.

The output of Adams County consisted of a few shipments of copper sulphide ore from the Seven Devils district, the value of which decreased from $10,881 in 1918 to $5,435 in 1919. A bulletin [5] published by the State of Idaho gives a detailed description of the geology and ore deposits of the region. A summary of the types of ore deposits follows:

The ore deposits of the Seven Devils district can be classified under four heads: (1) Mineralized shear zones, (2) fissure veins, (3) disseminated deposits of large size, and (4) contact metamorphic deposits.

Of these the last type has produced practically all the copper that has been credited to the district up to the present time. The disseminated deposits, of which the Red Ledge on Deep Creek is the most important, have considerable prospective

[5] Livingston, D. C., and Laney, F. B., The copper deposits of the Seven Devils and adjacent districts; Idaho Bur. Mines and Geology Bull. 1, 1920.

value and may ultimately be the big producers of the district, while the fissure veins have produced a little gold, as, for instance, at Black Lake, and some copper, as at the River Queen mine, which, however, lies outside the Seven Devils quadrangle.

BENEWAH COUNTY.

Camas Cove district (Tyson).—The placer production in 1919 of the region near Tyson was $2,410 in gold and 12 ounces of silver. The Cedar Creek property was operated for a short time by lessees.

BLAINE COUNTY.

Mine production in Blaine County, Idaho, in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	35	23,700	$13,114	228,428	22,785	2,285,324	1,489,083	$544,934
1919	16	24,033	13,220	273,279	18,643	2,157,300	.....	437,098
Increase or decrease, 1919	−19	+333	+106	+44,851	−4,142	−128,024	−1,489,083	−107,836
Total, 1880–1919	.....	.....	2,492,192	16,075,870	251,229	186,019,588	7,997,090	25,889,461

The value of the output of Blaine County decreased nearly 20 per cent, as no zinc ore was shipped in 1919. The ore and old tailings treated had an average value of $18.19 a ton and a value in gold and silver of $13.29 a ton. The material treated was divided into 24,011 tons of crude lead ore and tailings, 3 tons of siliceous ore, and 19 tons of copper-lead ore. Most of the ore, 13,126 tons, together with 10,000 tons of old tailings, was concentrated and produced 4,230 tons of concentrates valued at $320,527, or $75.77 a ton. There were 907 tons of crude ore shipped valued at $116,570, or $128.52 a ton. From 1880 to 1919 Blaine County has produced $2,492,192 in gold, $14,612,678 in silver, $47,144 in copper, $8,088,898 in lead, and $648,549 in zinc. The output of Blaine County by years to 1914 was published in Mineral Resources [6] for that year.

Mineral Hill district (Hailey).—Nine deep mines produced 10,171 tons of ore and tailings, which yielded $865 in gold, 32,085 ounces of silver, 8,863 pounds of copper, and 230,376 pounds of lead, valued in all at $50,659. Most of the output was old tailings, which was reduced to 1,688 tons of concentrate. Only 79 tons of crude ore was shipped. In 1918 the district produced ore and placer bullion valued at $19,601. Tailing from the Minnie Moore mine was treated in a 100-ton concentration mill, and small shipments of ore came from the Black Barb, Eureka, Bromide, and Lark mines. Work in drifts and raises was continued at the Nay Aug and Jay Gould mines.

Warm Springs district (Ketchum).—Seven deep mines produced 13,862 tons of ore, containing $12,355 in gold, 241,194 ounces of silver, 9,780 pounds of copper, and 1,926, 924 pounds of lead, valued in all at $386,439, or an average of $27.88 a ton. Most of the ore, 13,034 tons, was milled and made 2,542 tons of concentrates, and

[6] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 613, 1915.

828 tons was first-class shipping ore. Eighteen deep mines in 1918 produced 23,399 tons of ore, valued at $524,856. The Golden Glow Mining Co. operated the Ophir and Bazook claims and shipped several hundred tons of sulphide lead ore. Shipments were also made from the Hailey Bonanza and Homestake properties. The largest output of the district was that of the Independence mine of the Federal Mining & Smelting Co. Lead ore was treated in a 100-ton concentration mill, which was operated from March to November. According to the printed report [7] of the operating company, 13,386 tons of ore was mined from the Independence mine and the financial results, without deductions for ore depletion or taxes, were $82,952, which was more than twice the net profits from the Morning mine in Shoshone County. The ore reserves on January 1, 1920, are given as 53,000 tons, equivalent to about 7,000 tons of lead concentrate and 4,000 tons of first-class lead ore. The company report says:

> The lower tunnel to the Independence is nearing completion and will (*a*) permit steady operation of the mine the year round, instead of a shutdown, as heretofore, during the period of danger from snow slides, and (*b*) will permit the use of the North Star mill, thus increasing output and reducing cost.

The North Star mine, which produced considerable zinc in 1917 and 1918, was idle in 1919. Metallurgic difficulties prevented profitable operation. Work at the Silver Triumph mine consisted of cleaning out the old workings. The mine has 5,000 feet of drifts, 2,335 feet in crosscuts, and a 300-foot shaft.

BOISE COUNTY.

Mine production in Boise County, Idaho, in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	29	24,711	$226,793	29,578	2,917	30,501	$259,257
1919	24	40,830	418,450	14,883	3,208	1,015	435,770
Increase or decrease, 1919	−5	+16,119	+191,657	−14,695	+291	−29,486	+176,513

[a] Includes placer production of $5,607 in gold and of 73 ounces of silver in 1919.

The output of gold in Boise County increased decidedly in 1919. Twelve deep mines produced 40,830 tons of ore, averaging $10.53 a ton. Nearly all this ore, 39,871 tons, was treated in gold and silver mills and only 27 tons was shipped to smelters. Bullion in the ore milled was valued at $314,885, or $7.90 a ton in gold and silver. All the output was siliceous, except 24 tons, which was copper ore. The small placer output in 1919 was from 12 properties compared with 19 placers in 1918, which produced $51,538 in gold and 692 ounces of silver.

The production of gold and silver in the county, exclusive of copper and lead, from 1863 to the end of 1919 was $52,747,582 in gold and

[7] Federal Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1920.

2,196,327 ounces of silver. The output by years to 1914 was given in the report [8] for that year.

Boise Basin district (Placerville, Quartzburg, Idaho City).—Ten deep mines and 12 placers produced 40,817 tons of ore, $418,273 in gold, 14,420 ounces of silver, 3,162 pounds of copper, and 908 pounds of lead, valued in all at $435,060, in 1919, a large increase over that of 1918, which was valued at $238,022. Most of the ore—39,861 tons—was treated in gold and silver mills, 932 tons was concentrated, and 24 tons was shipped. The Gold Hill & Iowa Mines Co., at Quartzburg, produced most of the gold of the district and operated a 150-ton mill equipped for amalgamation and concentration. A 10-ton cyanidation plant was built to treat the iron concentrates, but these were smelted in 1919. Gold bullion was also recovered at the Boulder, Cash Register, and Hay Fork mines; concentrates were shipped from the Golden Age Junior; and sulphide copper ore was shipped from the Gem of the Mountains property. It is planned to treat the low-grade ore from the Golden Age Junior mine by the Koering cyanide process. The old drifts of the Diamond L. property, which includes a 40-ton Elspass mill, were put in shape for development and production. Since the dredge at Idaho City ceased operations the placer output of the district has greatly decreased. In 1919 it was $5,607 in gold and 73 ounces of silver, against $51,516 in gold and 691 ounces of silver in 1918. Most of the gold came from the Crevice Diggings, Native Missourian, Ophir, and Lucy placers. Notable development work was done at the Belshazzar property, operated by the Idawa Mining Co.

Payette River district (Banks).—A test lot of silver ore was shipped from the Three Sisters group, which is being developed by the Alpine Mining Co.

Summit Flat district (Centerville).—The Gold Dollar mine on King Mountain, at the head of Grimes Creek, was in the hands of lessees, who produced a small amount of gold bullion.

BONNER COUNTY.

There was a decrease of $12,607 in the value of the output of Bonner County in 1919. Nearly all the ore came from the Lawrence mine, in the Pend Oreille district, which produces lead ore. High-grade lead concentrate was shipped to Utah, and a car of silver ore was shipped from the B. F. & H. mine. At the Keystone property, operated by the Armstead Mines (Inc.), development work was continued by connecting the lower tunnel 3,600 feet long with the one 600 feet above and by opening the vein at various levels between. The construction of a milling plant was postponed. The Interstate Sullivan Co. reported the expenditure of much money in the purchase of machinery, the building of roads, and development work. In the Lakeview district some development work was done at the Fall Creek mine, which is equipped with a 50-ton ball mill.

BONNEVILLE COUNTY.

Mount Pisgah district (Gray).—The Idaho Mining & Dredge Co. produced some gold by hydraulic mining at the American placer, and the Barnes group was active for a short time.

[8] U. S. Geol. Survey Mineral Resources, 1914, pt. 1, p. 616, 1915.

BOUNDARY COUNTY.

Moyie Yahk district.—The Idaho Gold & Ruby Co. reported work on ditch and sluice boxes in preparation for hydraulic mining. Development work was done on the Dora lode property.

Porthill district (Klockmann).—The Idaho Continental property, at Klockmann, produced a large quantity of lead ore, which was concentrated in a 250-ton plant. The property was active for eight months of the year and high-grade concentrate was shipped to International, Utah. In August 130 men were employed and 12 motor trucks hauled ore to Porthill, on the Great Northern Railway.

BUTTE COUNTY.

Antelope district.—Several hundred tons of oxidized lead ore was shipped from the Lead Belt mine, near Darlington.

CAMAS COUNTY.

Several small shipments of ore were made from the Little Smoky and Rosetta districts. Considerable development work was done on the property of the Associated Mines, in Little Smoky district. The El Oro mine, a producer of gold ore in Skeleton Creek district, was idle.

CASSIA COUNTY.

The Melcher mine, in the Stokes district, 12 miles south of Albion, was operated for a short time, and a shipment of concentrate was made from the new mill. Difficulty in obtaining electric power prevented further operations.

CLEARWATER COUNTY.

One deep mine and 6 placers in Clearwater County produced $11,747 in gold and 138 ounces of silver in 1919. The value of the output was $11,902 in 1919, $4,920 in 1918, and $17,503 in 1917. Results from placer operations in the Pierce and Moose Creek districts were small, though the dredge of the Pierce Co. was active part of the year. The Hay Creek placer, near Pierce, was also productive.

CUSTER COUNTY.[a]

Nineteen deep mines produced 15,541 tons of ore in 1919, a decrease of 46,758 tons. The production of the county, including the output of one placer, was $15,292 in gold, 102,366 ounces of silver, 1,352,487 pounds of copper, and 936,898 pounds of lead, valued in all at $431,161. The ore had an average value of $27.74 a ton, of which the value of the gold and silver was $8.36. In 1918 the output was valued at $1,342,619. The ore was divided into 13,504 tons of copper ore, 1,980 tons of lead ore, and 57 tons of siliceous ore. Most of the product was crude ore shipped to the smelters, 15,525 tons, valued at $430,792, or $27.75 a ton. Only 16 tons of ore was treated by amalgamation.

[a] For the geology of part of Custer County see Umpleby, J. B., Some ore deposits in northwestern Custer County, Idaho: U. S. Geol. Survey Bull. 539, 1913.

Alder Creek district (Mackay).[9]—Eight deep mines produced 14,328 tons of ore, which yielded $14,065 in gold, 47,912 ounces of silver, 1,322,084 pounds of copper, and 457,128 pounds of lead, valued in all at $337,862, or an average of $23.58 a ton. In 1918 the mines of the district produced 58,971 tons of ore valued at $1,087,044. All the ore was shipped to smelters near Salt Lake City, Utah. The Empire Copper Co. shipped about 1,000 tons of copper ore a month instead of 4,000 tons a month as in 1918. Considerable time was devoted to exploration and development work, as the ore reserves were nearly exhausted during the period of the war. The ore is carried by aerial tramway from the mine at White Knob to the loading station near Mackay. Much oxidized lead ore was shipped from the Horseshoe mine under lease, and several shipments came from the Doughboy mine, where new ore was opened. Other shipments were made from the Black Daisy, Copper Basin, Keenan, and L. & S. mines. The development of the lead mines created some activity in the region around White Knob.

Bayhorse district (Clayton).—Seven deep mines produced 1,144 tons of ore, which yielded $85 in gold, 52,714 ounces of silver, 29,963 pounds of copper, and 467,788 pounds of lead, valued in all at $89,491, or an average of $78.23 a ton. Several hundred tons of oxidized lead ore was shipped from the Red Bird property of the Clayton Mining & Smelting Co., and both lead ore and copper ore rich in silver were shipped from the Ramshorn mine. The old mill at this property was remodeled and a 50-ton flotation plant was installed. In the mine one adit 3,000 feet long was retimbered, air lines laid, and compressor installed.

East Fork district.—A small quantity of gold bullion was produced from the Dewey and other claims near Obsidian.

Sea Foam district.—The Montana mine produced one shipment of lead ore, containing considerable gold and silver.

Stanley Basin district.—The output of the Stanley Basin district consisted of a shipment of lead ore from the Mountain Girl claim and a little gold from the Hohman placer.

ELMORE COUNTY.

Four deep mines and four placers in Elmore County produced gold and silver valued at $2,948. The value of the ore decreased from $7.99 a ton in 1918 to $6.45 in 1919. The mines are far from transportation and the ore is difficult to treat.

Bear Creek district.—A small amount of placer gold was won from claims near Rocky Bar, and development work was done at the Vibrator and Ella & Eagle properties.

Highland district (Twin Springs).—The Last Chance placer, near Twin Springs, made a small production.

Middle Boise district (Atlanta).—At the General Pettit mine, formerly a large producer of gold and silver, several hundred tons of ore was milled for testing purposes. The Atlanta Mines Co. was idle, but some gold was produced at the Idaho Bonanza placer. At the Minerva mine, an old producer, 600 feet of crosscutting was done.

[9] Umpleby, J. B., Geology and ore deposits of the Mackay region, Idaho: U. S. Geol. Survey Prof. Paper 97, 1917.

Neal district.—A test run was made in a small mill at the Gold Bug property, but freezing prevented the clean-up.

Pine Grove district.—Sample lots of silver ore were shipped from the region near Mountain Home.

Snake River district.—The Edna placer was operated a short time by the Western Exploration Mining Co.

FREMONT COUNTY.

The Skull Canyon mine, near Reno, which was idle most of the year, produced one shipment of oxidized copper ore.

GEM COUNTY.

West View district (Pearl).—Four deep mines produced 487 tons of ore, containing $1,118 in gold, 18,352 ounces of silver, 960 pounds of copper, and 1,720 pounds of lead, valued in all at $21,941, or an average of $45.05 a ton. All the material was siliceous silver ore shipped to smelters, and most of it was mined at the Zula Pearl property. Nearly 1,000 feet of development work was done in 1919. Other shipments were made from the Liberty and North Basque mines.

IDAHO COUNTY.

Mine production in Idaho County, Idaho, in 1918 and 1919.

Year.	Number of producers.		Ore.	Gold.[a]	Silver.[a]	Copper.	Total value.
	Deep mines.	Placers.					
			Short tons.		*Fine ounces.*	*Pounds.*	
1918	22	16	15,567	$82,059	4,987	.....	$87,046
1919	9	24	1,084	13,060	570	867	13,859
Increase or decrease, 1919	−13	+8	−14,483	−68,999	−4,417	+867	−73,187

[a] Includes placer production.

Although the total output decreased greatly, the average value of the output from deep mines in Idaho County increased from $5.27 a ton in 1918 to $8.20 a ton in 1919. Nearly all the ore, or 462 tons, and 567 tons of old tailings, was treated in gold and silver mills and produced bullion valued at $7,511, or $7.30 a ton.

Camp Howard district.—A small amount of placer gold came from the Cape Horn and Klondyke claims, near Whitebird.

Clearwater district (Grangeville).—One shipment of gold ore, containing silver and copper, was made from the Dewey claim of the Clearwater Copper Co.

Cottonwood district.—Lessees made one shipment of siliceous gold ore from the Rocky Butte mine.

Dixie district.—A little placer gold was mined from the James Moore and other claims near Dixie.

Elk City district.—Three placers and one deep mine produced 5 tons of ore, $964 in gold, and 12 ounces of silver, in all valued at $977. In 1918 mines in the district produced $3,038 in gold and silver and

made much larger production in previous years. The placer gold came principally from the Red Rock and Erickson placers.

Florence district.—A small production came from the Bevier placer, near Florence.

Marshall Lake district (Burgdorf).—The Sherman & Corporal property, an important producer of gold in 1917 and 1918, made a small production in 1919. Development work in drifts and raises was continued, and a 50-ton cyanide plant was added which treated several hundred tons of old tailings. Drifting was continued at the Jupiter and Mount Marshall mines.

Newsome district.—Three placers produced $729 in gold and 4 ounces of silver, most of which was mined at the Moose Creek placer.

Orogrande district.—The Orogrande Gold Mining Co. operated the old Crooked River property, which contains a large deposit of low-grade gold ore. Production, however, was small in 1919. The work consisted in remodeling the mill, which is being equipped for concentration and cyanidation, and in development work in the mine. The plant has a 20-stamp mill, two pebble tube mills, and a 200-ton cyanide plant.

Simpson district.—Drifting and sluicing operations were carried on at the Lima Point claim, near Lucile.

Ten Mile district.—Two deep mines and two placers produced 214 tons of ore, $3,747 in gold, and 64 ounces of silver, valued in all at $3,818. The ore had an average value of $15.98 a ton. Most of the gold came from the New York and Buckhorn mines, near Golden. The placer gold was mined at the Crescent and Phoenix claims.

Warren district.—Five placers and one deep mine produced 102 tons of ore, $3,205 in gold, and 53 ounces of silver, valued in all at $3,265. The value of the output of the district in 1918 was $21,505. Production from the mines of this district, as well as others in Idaho County, has been seriously curtailed by the expense of gold mining. The Idaho Standard Mines Co., which has produced much gold in recent years, was idle. The Little Giant mine was operated by the Unity Gold Mines Co., which did 1,000 feet of work in drifts and tunnels, and some gold and silver bullion was won by amalgamation. A 50-ton mill equipped for amalgamation and concentration was completed by the company. The placer output came from the Blue Bird, Buck Diggings, Golden Rule, and Relief claims.

Unorganized district.—The Fisher and Buck Meadows placers were slightly productive.

LATAH COUNTY.

Hoodoo district.—The production consisted of placer gold from the Hard Work and Carrico placers, near Harvard, and a shipment of sulphide copper ore from the Mizpah mine of the Merger Mining Co. The mine was operated for three months, and a new hoist was installed. A short article[10] on the district was recently published, which summarizes conditions in the following paragraph:

> The underground work done in the district has shown that there are two types of mineral deposits, one consisting of bedded or blanket deposits where pyrrhotite and chalcopyrite together with numerous other nonmetallic minerals, some of which are suggestive of contact metamorphism, have been deposited in a somewhat sparse manner

[10] Livingston, D. C., and Laney, F. B., The copper deposits of the Seven Devils and adjacent districts: Idaho Bur. Mines and Geology Bull. 1, p. 97, 1920.

along sills of hornblende-diorite and the adjacent beds of quartzite and schist. The other type is a fissure, possibly at one time occupied by a dike of hornblende-diorite which follows the strike of the metamorphics but cuts them on the dip and in which the schist wall rock has been replaced by chalcopyrite and pyrrhotite, the former predominating and occurring throughout the fissure in massive lenses. The low-grade blanket deposits dip toward the fissure deposit, and it is highly probable that shoots of ore will occur at their junction with the fissure.

LEMHI COUNTY.[11]

Mine production in Lemhi County, Idaho, in 1918 and 1919.

Year	Number of producers.		Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
	Deep mines.	*Placers.*	*Short tons.*		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	32	7	12,253	$40,829	136,871	103,663	5,454,251	$590,557
1919	20	8	17,570	44,299	134,812	156,610	5,675,567	525,222
Increase or decrease, 1919.	−12	+1	+5,317	+3,470	−2,059	+52,947	+221,316	−65,335

[a] Includes placer production of $3,407 in gold and 22 ounces of silver in 1919.

The output in 1919 from deep mines in Lemhi County was valued at $521,790, or an average value of $29.70 a ton, and the value of the gold and silver content was $10.92 a ton.

The placer output in 1919 was valued at $3,432 compared with $17,496 in 1918. Only one dredge was operated during part of the year. Most of the ore, or 11,894 tons, was shipped directly to smelters and had a total value of $496,220, or an average of $41.72 a ton. Gold and silver mills treated 121 tons of ore, which yielded gold and silver valued at $1,184, and 5,555 tons was concentrated. The ore was classified as 14,790 tons of lead ore, 2,333 tons of siliceous ore, and 447 tons of copper ore.

Carmen Creek district (*Salmon*).—A test shipment of ore was made from the Vimedsi claim, on Boyle Creek.

Eldorado district (*Salmon*).—A shipment of copper ore was made by the Harmony Mines Co., near Baker, Idaho. Development work consisted in 1,176 feet of drifting, and the construction of a 100-ton mill equipped for concentration was begun in November. Several hundred tons of sulphide copper ore was shipped from the Pope Shenon property, but most of the time was consumed in the construction of a 50-ton mill, which is designed to use a process involving volatilization. It is planned to crush the ore to 10-mesh, mix it with salt, and heat it in a retort kiln to volatilize copper as chloride of copper, which is reduced to the metallic state by fusion with lime and coke.

Eureka district.—Two deep mines and one placer produced 31 tons of ore, $1,423 in gold, 48 ounces of silver, and 10,679 pounds of copper, valued in all at $3,463. The Mullen dredge, on Moose Creek, was operated for a short period, and one shipment of copper ore was made from the Green Horn mine.

Indian Creek district (*Ulysses*).—A small amount of gold bullion was shipped from the Kittie Burton mine, operated by the Buchanan Mining & Leasing Co. Most of the work consisted in putting the mine in shape for production and repairing the mill and tram line.

[11] Umpleby, J. B., Geology and ore deposits of Lemhi County, Idaho: U. S. Geol. Survey Bull. 528, 1913.

Junction district.—The Sunset Mining Co. operated the Leadville group, near Junction, and shipped a considerable quantity of both crude lead ore and concentrate. The mill ore was treated in a 50-ton concentration plant. Aside from the output of the Texas district this was the largest lead production of the county. A promising deposit of lead ore is reported to have been opened at the Kimmel property.

Mackinaw district (Leesburg).—Three placers produced $1,893 in gold and 17 ounces of silver. Most of the gold was mined at the Hockensmith and Richardson placers.

Mineral Hill district (Shoup).—The production from one placer and three deep mines was 175 tons of ore, $4,473 in gold, and 63 ounces of silver, valued in all at $4,543. The output came principally from the Kentuck mine, the result of several shipments of concentrate containing gold and silver.

Pratt Creek district.—The Climax mine, near Baker, was operated for a short time and produced some gold and silver bullion through the operations of a lessee.

Spring Mountain district.—Two mines in this district produced lead ore valued at $5,653, or an average of $42.83 a ton, against $13,255 from three deep mines in 1918. Most of the ore came from the Winnie group, in Big Horseshoe Gulch, and the remainder from the Lemhi Union property. At the Silver Consolidated property 400 feet of tunneling was done.

Texas district (Gilmore).—Seven deep mines produced 10,999 tons of ore, containing $35,357 in gold, 123,207 ounces of silver, 47,634 pounds of copper, and 5,282,177 pounds of lead, valued in all at $462,164, or an average of $42.02 a ton. Ten deep mines in 1918 produced 9,491 tons of ore, valued at $500,619. All the ore was shipped to the smelters without previous treatment. In 1919 as in former years, the main producers were the Pittsburgh-Idaho, Latest Out, and Gilmore mines. The first two mines produced oxidized lead ore and the Gilmore produced iron ore, containing considerable gold, and oxidized lead ore. About 400 tons of ore a month was shipped from the Pittsburgh-Idaho property and about 300 tons a month from the Latest Out. Other shipments came from the Brown Bull and Tidal Wave mines.

OWYHEE COUNTY.

Mine production in Owyhee County, Idaho, in 1918 and 1919.

Year.	Number of producers.		Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
	Deep mines.	Placers.	*Short tons.*		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	12	2	2,187	$8,742	30,735	907	987	$39,771
1919	6	1	2,703	4,297	27,880	53	102	35,538
Increase or decrease, 1919.	−6	−1	+516	−4,445	−2,855	−854	−885	−4,233

[a] Includes placer production.

The ore from deep mines in Owyhee County had in 1919 a total value of $13.10 a ton, practically all of which was for gold and silver. The entire product was siliceous and most of it was concentrated. The production of gold and silver in the county from the discovery of gold in 1863 to 1919, inclusive, was $21,656,643 in gold and 24,438,397 ounces of silver, having a total value of $40,499,125. The placer output was small.

Carson district (Silver City).[12]—Four deep mines and one placer produced 2,304 tons of ore, $3,850 in gold, and 26,349 ounces of silver, in all valued at $33,361. The old Trade Dollar mine was operated by the Florida Mountain Mines Co. and produced gold and silver from concentrates shipped to various smelting plants. The De Lamar mine was opened, old crosscuts and drifts retimbered, and the concentration mill repaired.

Castle Creek district.—The Evans mine, near Grandview, was operated by the Rough Mountain Mines Co., and a few tons of ore containing gold and silver was shipped to Murray, Utah. Development work in 1919 consisted of 900 feet of crosscuts.

Steele district (Oreana).—The 100-ton mill at the Demming property was operated for 10 days during 1919, and a shipment of concentrate containing gold and silver was sent to the smelter at Midvale, Utah. The property is being developed, and the construction of the flotation mill was completed. Development consisted of 1,800 feet of drifts and 100 feet of shafts, and an addition was built at the milling plant where roaster and cyanide tanks were installed.

SHOSHONE COUNTY.[13]

Mine production in Shoshone County, Idaho, in 1918 and 1919.

Year.	Number of producers.		Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
	Deep mines.	Placers.							
			Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	47	5	1,918,052	$245,450	8,447,219	2,706,535	278,613,238	43,661,314	$33,115,903
1919	33	5	1,308,063	179,582	4,815,200	1,474,642	167,666,932	15,994,229	15,900,815
Decrease, 1919	14	0	609,989	65,868	3,632,019	1,231,893	110,946,306	27,667,085	17,215,088
Total, 1884-1919				6,033,431	178,366,181	72,235,606	[b] 2,870,517	394,306,984	458,952,047

[a] Includes placer production of $156,443 in gold and 1,535 ounces of silver in 1919.
[b] Short tons.

Shoshone County, or the Coeur d'Alene region, continues to be the most important mining center of the State. It comprises several mining districts, the production of each of which is given separately.

[12] Lindgren, Waldemar, The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho: U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, p. 75, 1900.

[13] Ransome, F. L., and Calkins, F. C., Geology and ore deposits of the Coeur d'Alene district, Idaho: U. S. Geol. Survey Prof. Paper 62, 1908.
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The average value of the ore from deep mines in 1919 was $12.04 a ton, and the value in gold and silver was $4.14 a ton. The corresponding values in 1918 were $17.17 and $4.43. The value of the output of the county decreased nearly 52 per cent, but it represented nearly 87 per cent of the total value of the output of the State. The decrease was general, but especially large in lead, silver, and zinc. The output of lead ore ranked first with 1,063,830 tons, and lead-zinc ore was next with 206,150 tons. Copper ore amounted to 36,182 tons, siliceous ore 423 tons, and zinc ore 1,478 tons. Nearly 76 per cent of the total ore of the State (1,103,907 tons) and 155,483 tons of old tailings from Shoshone County were concentrated and reduced to 185,600 tons of concentrates, which yielded $16,807 in gold, 3,622,390 ounces of silver, 981,905 pounds of copper, 142,125,302 pounds of lead, and 14,760,893 pounds of recoverable zinc, in all valued at $12,866,705, or $69.32 a ton. These concentrates were classified as 2,444 tons of copper concentrates, containing 95.77 ounces of gold, 99,436 ounces of silver, and 714,790 pounds of copper; 164,604 tons of lead concentrates, containing 717. 27 ounces of gold, 3,468,510 ounces of silver, 267,115 pounds of copper, and 140,522,566 pounds of lead; 15,360 tons of zinc concentrates, containing 29,244 ounces of silver, 1,257,736 pounds of lead, and 12,418,293 pounds of recoverable zinc; and 3,192 tons of lead-zinc concentrates, containing 25,200 ounces of silver, 345,000 pounds of lead, and 2,342,600 pounds of recoverable zinc. Fifteen milling plants, having a combined daily capacity of approximately 7,200 tons, were active during the greater part of the year. These mills were concentration plants, and 13 of them used flotation cells.

Of the county ores treated or shipped, 48,673 tons was first-class crude ore, containing $6,333 in gold, 1,191,275 ounces of silver, 492,737 pounds of copper, 25,541,630 pounds of lead, and 1,233,336 pounds of recoverable zinc, valued in all at $2,875,949, or $59.09 a ton. The crude ore smelted included 423 tons of siliceous silver ore, containing 2.89 ounces of gold, 14,094 ounces of silver, and 8,066 pounds of copper; 1,498 tons of copper ore, containing 179.68 ounces of gold, 1,993 ounces of silver, and 262,339 pounds of copper; 45,274 tons of lead ore, containing 123.77 ounces of gold, 1,174,326 ounces of silver, 222,332 pounds of copper, and 25,480,851 pounds of lead; and 1,478 tons of zinc ore, containing 862 ounces of silver, 60,779 pounds of lead, and 1,233,336 pounds of recoverable zinc. Five placer mines in the county produced $156,443 in gold and 1,535 ounces of silver.

The production of the Coeur d'Alene region by years, from 1884 to 1913, was given in the report for 1913.[14] From 1904 to 1919 the operators in the region mined, shipped, or treated 29,936,670 tons of ore.

Though conditions in 1919 were not favorable for a large output of ore, development in several of the large producing mines was most encouraging. The ore body of the Bunker Hill mine has been opened at the fifteenth level, the deepest working of the mine, where it is as extensive and rich as in the levels above. Ore persists at a depth of 2,000 feet in the Hecla mine. Milling ore and first-class ore continue to be mined at the eighth level below the No. 5 adit in the Hercules property. A large body of low-grade ore was discovered in

[14] U. S. Geol. Survey Mineral Resources, 1913, pt. 1, p. 780, 1914.

the Gold Hunter mine above the No. 4 level. A body of high-grade lead-zinc ore, identical with the big vein above, was opened on the 500-foot level of the Interstate-Callahan mine. Ore was mined in the Tamarack & Custer property from the Puritan tunnel on the level of Ninemile Creek 400 feet below the No. 4 tunnel.

Beaver district.—One deep mine and two placers had an output valued at $1,484,511, or an average value for the ore of $27.41 a ton. The output of three deep mines and three placers was valued at $4,181,536 in 1918. Most of the ore, 52,526 tons, was milled and produced 19,547 tons of concentrates. The remainder, 1,609 tons of first-class ore, was shipped to the various smelters. The Midnight placer, near Murray, was operated for a short time. The Consolidated Interstate-Callahan Mining Co. was operated for seven and one-half months and produced for more than four months. According to the statement to the assessor, 67,952 tons of ore was extracted, having a gross value of $741,917. The cost of extraction was $541,207; freight and treatment, $238,650; betterment and repairs, $52,872; and net loss, $90,812. The following paragraphs are taken from the company's report:[15]

The actual mining and shipping operations covered a period of only four and one-half months, full operations being carried on in January and February, the last half of October, November, and December. During the remainder of the year development work in the mine and alterations and additions to our milling plant were carried on with a small force of men.

In so far as shipments were concerned, January and February were record months for the company, but on account of enormous increases in all operating costs during the war period, and the great decrease in the markets for lead and zinc at the close of the war, it was impossible to operate with reasonable profit. The directors, therefore, after careful consideration, deemed it for the best interests of the stockholders to suspend operations and conserve the resources of the mine until such time as the metal market situation would permit the company to operate with a better margin of profit. * * * The zinc market advanced from around 5 cents in January to 8¾ cents at the close of the year, and lead advanced from 5 cents early in the year to about 8 cents in December. Silver, which is a very considerable by-product of our lead shipments, advanced from $1.01 an ounce in January to the highest point ever known, above $1.35 an ounce, at the close of the year. During the first months of the year nearly all metals were practically a drug on the market, while the close of the year saw an enormous demand, both domestic and foreign, for all the metals produced by our company, and with every indication of still greater advances. * * *

The earnings from operations, covering a period of four and one-half months only, were $494,263 63. In addition to this there was realized from the sale of stocks and bonds $478,401.46, making a total income for the year of $972,665.09. Expenditures for the year amounted to $602,902.32, which included the production cost of shipments, general operating expenses, maintenance of the property and development work, new construction and improvements, and other sundry charges, * * * which leaves a surplus for the year of $369,762.77. Adding to this amount the adjusted surplus as of December 31, 1918, and deducting the investments in other mining properties, we have a total accumulated surplus of $618,630.14 on December 31, 1919, * * * No dividends were paid during the year.

During the period from March 1 to October 15, while mining and shipping operations were suspended, the company carried on extensive development work, with the result that the most important discovery in the Interstate-Callahan in recent times was made. This ore was encountered in a crosscut north on the 500 level, and consists of a large body of high-grade ore, assaying as high as 34 per cent lead, 31 per cent zinc, and 7 ounces of silver to the ton. The new ore body is identical with the big vein that has made the mine one of the largest producers of zinc-lead in the United States. The ore body has widened out with further development from 2 feet to 23½ feet, and is continuous from the No.6 to the No. 4 levels, which is as far as development has progressed at this writing. * * *

[15] Consolidated Interstate-Callahan Mining Co. Seventh Ann. Rept., for year ending Dec. 31, 1919.

The following development work has been done during the year: Three hundred and fifty-five feet of crosscuts, 411 feet of raises, 322 feet of drifts, and 1,768 cubic feet of stations. * * *

It has been the policy of our company to increase its property holdings, and in carrying out this policy we have acquired, either outright or by majority interests, the Nipsic mining property, the Silver State mining property, the Blue Grouse property, and the Virginia mining claim, all adjoining or adjacent to the Interstate-Callahan mine. All of these properties have the earmarks of making valuable additions to the Interstate-Callahan, and further development work will be done on these properties during the coming year.

During the twelve months' period covered by this report the mill also worked only four and one-half months. While it was closed down we completed the selective flotation lead unit that we started to install during 1918. We also installed an 8-foot Hardinge ball mill, two drag classifiers, repaired the launder system and elevators, installed a new fresh-water supply system, four K and K flotation machines, a new 30 by 10 foot Dorr thickening tank, and made other numerous alterations and repairs. The new installations, together with the other work that was done at the mill, have shown very gratifying results, especially our selective flotation lead unit that was completed just before we resumed operations.

Our entire zinc product is now made in the flotation plant, and averages 51.5 per cent zinc, with 4.1 per cent lead. Our lead shipments average 58.9 per cent lead and 20.6 ounces of silver per ton. * * *

We have built a new sorting plant just above our tram terminal at the mine. All ore passes through this plant, the waste and ore being handled on conveyors. The clean waste sorted from the belt is dropped into a hopper, and from there loaded into mine cars and returned to the mine for filling, which saves us breaking this amount of rock in the mine for filling, as had to be done when all sorting was done at the mill. * * *

The additional ore developed between the No. 5 and No. 6 levels and above the No. 5 level to the east and south of the porphyry dike, has added materially to our known ore reserves, and I believe we are conservative in estimating our present high-grade ore reserves as of January 1, 1920, at approximately 310,000 tons. This figure does not take into consideration the low-grade ore in the mine that eventually will be extracted, or the ore in the tailings dump at the mill. * * *

Our entire production is contracted for for some time to come, the lead-silver going to the American Smelting & Refining Co., and the zinc going to the Grasselli Chemical Co., of Cleveland. * * *

The ore body recently opened up runs very high in lead silver, and our shipments of these metals at the close of 1919 were fully one-third of our total production.

The company has fully recovered from its long shutdown and the labor strike which disrupted its mine organization to quite an extent. We are now employing our normal force of about 350 men, and from this time on will ship our regular monthly tonnage of approximately 6,000 tons. The mill is very efficient, and the ore recoveries and the metal assays are higher than we have ever produced. * * *

During 1919 only 67,952 tons of ore was mined, of which 52,526 tons was milled. The first-class ore consisted of 634 tons of lead ore and 975 tons of zinc ore, and the concentrates consisted of 4,722 tons of lead concentrate and 14,825 tons of zinc concentrate. The lead ore and concentrate contained 103,047 ounces of silver and 6,186,124 pounds of lead, as well as zinc not paid for. The zinc ore and concentrate contained 36,229 ounces of silver, 1,807,540 pounds of lead, and 15,149,802 pounds of gross zinc.

The Friend Mining Co., which owns a small mill consisting of crusher and jigs, did some development work in 1919.

Coeur d'Alene district.—The Yukon Gold Co. operated its dredge near Murray and made the second largest production of gold in the State. The plant has a capacity of 7,000 cubic yards in 24 hours, is driven by electric power, and has 70 buckets, each of which has a capacity of 7½ cubic feet. According to the figures to the county assessor, the dredge treated 1,519,035 cubic yards of material, the gross value of which was $157,806. The cost of extraction was $94,878, freight and treatment $782, betterment and repairs $7,500,

and net profit $54,645. The printed report [16] states that the material handled averaged 10.39 cents a cubic yard and that the average cost, including depreciation, was 9.05 cents a cubic yard; excluding depreciation, 7.06 cents. A description of the plant and the details of operation were published in a recent article.[17]

Eagle district.—Several shipments of high-grade lead ore were made from the Jack Waite property, though the mine was not actively operated in 1919.

Evolution district.—Four deep mines produced 465 tons of ore, containing $30 in gold, 29,636 ounces of silver, 5,451 pounds of copper, and 158,728 pounds of lead, valued in all at $42,649, or an average of $91.72 a ton. In 1918 the value of the output was $64,878. The largest producer was the Yankee Boy mine, operated by the Big Creek Leasing Co. All the ore, which contains considerable silver, was shipped to various smelting plants. The H. E. M. mine was operated by the Western Union Mining Co. and produced a few shipments of sulphide lead ore. Other producers were the Mineral Point and Polaris properties. Ore from the Silverado mine was tested by flotation. The mill feed was said to contain 6 ounces of silver to the ton, 0.35 per cent of copper, and 2.6 per cent of lead. The concentrate contained 83 ounces of silver to the ton, 5.4 per cent of copper, and 40 per cent of lead.

Hunter district (*Mullan*).—Three deep mines produced 328,998 tons of ore, containing $4,812 in gold, 984,464 ounces of silver, 734,890 pounds of copper, 29,281,327 pounds of lead, and 2,342,600 pounds of recoverable zinc, valued in all at $2,967,021, or an average of $9.02 a ton. The output was divided into 317,451 tons milled, which produced 32,211 tons of concentrates, and 11,547 tons of shipping ore. In 1918 the mines produced 476,674 tons of ore, valued at $5,328,556. The Morning mine, of the Federal Mining & Smelting Co., was closed on account of a labor strike from August 15 to October 25, but notwithstanding this idleness made a valuable production of silver, lead, and zinc in both crude ore and concentrates. According to the report to the county assessor, 172,337 tons of ore was extracted, which had a gross value of $1,557,745. The cost of extraction was $957,190, freight and treatment $567,043, and net profits $33,512. In 1918 the net profit from the Morning mine was $761,369. The printed report [18] of the company states that on January 1, 1920, the ore reserves (fully developed) of the mine were 1,088,600 tons, equivalent to 67,930 tons of lead concentrate, 100,590 tons of zinc concentrate, and 75,800 tons of first-class lead ore. The report continues:

> The year opened with the immediate reaction in production due to the sudden and severe fall in the price of metals following the armistice.
>
> Toward the middle of the year, as the acute phase of readjustment was lessening in intensity, labor troubles in the Coeur d'Alenes began to develop, culminating in a strike which closed the Morning mine and every mine in the district save one for a period of some six weeks. The disorganization of forces and the necessity of doing much reconstruction work after so long a shutdown, made it impossible to get the Morning mine again in operation before well into November. * * *

[16] Yukon Gold Co. Eleventh Ann. Rept., for year ending Dec. 31, 1919.
[17] Rickard, T. A., The old diggings and modern dredge operations: Min. and Sci. Press, Feb. 7, 1920, p. 185.
[18] Federal Mining & Smelting Co. Ann. Rept. for year ending Dec. 31, 1919.

Owing to the very uncertain conditions prevailing through the larger part of the year, it was impossible to carry on the normal development work in the Morning mine

The company acquired no new properties, but at the present writing has several under investigation.

The Star litigation, alluded to in our last annual report, has not at this writing been decided. The case was argued in the Circuit Court of Appeals for the Ninth Circuit in February, 1919.

Without in any sense attempting to prophesy as to the total result for the year 1920, it may be said that the situation at this time is brighter than a year ago. * * *

Our Brewster mine, in Oklahoma, is now in full operation and should, under normal conditions, be a steady revenue producer.

The company received $1,767,153 from the sale of ore from all properties and paid $449,479 in dividends in 1919. The net profit from various sources, not making any deductions for ore depletion or taxes, was $402,496, separated as follows: Lessees at Burke and Mace, $23,084; Lucky O. K. mine, in Kansas, $134,619; Brewster mine, in Oklahoma, $128,329; Independence mine, at Ketchum, $82,952; and Morning mine, near Mullan, $33,512.

The Gold Hunter mine, east of Mullan, was operated throughout the year and shipped concentrates at the rate of about 900 tons a month. Development work consisted of 1,219 feet of drifting and 295 feet of raises. According to the figures given to the county assessor, 132,921 tons of ore was extracted, having a gross value of $821,456. The cost of extraction was $463,762, freight and treatment $279,134, betterment and repairs $11,623, and net profit $66,937.

The National mine was operated for about six months during 1919, and the 500-ton mill concentrated a large quantity of low-grade copper ore. Several thousand tons of concentrate, containing about 40 ounces of silver to the ton and 15 per cent of copper, was shipped to Tacoma. Development work consisting of 1,440 feet in crosscuts and 1,785 feet of diamond drilling was done by the Idaho Carbonate Hill Consolidated Mining Co., which is said to have opened a 5-foot vein of silver-lead ore. Some work was also done at the Daisy, Mayflower, Silver Cliff, Wall Street, and West Hunter properties.

Lelande district (Burke, Mace, Frisco).—Eight deep mines produced 280,326 tons of ore, containing $4,466 in gold, 1,420,451 ounces of silver, 161,661 pounds of copper, 43,718,529 pounds of lead, and 386,312 pounds of zinc, valued in all at $3,970,723, or an average of $14.17 a ton. Most of the ore, 265,867 tons, was reduced to 33,222 tons of concentrate and 14,059 tons was shipped directly to smelters. In 1918 eight deep mines produced 577,743 tons of ore, valued at $11,751,331, and the district had the largest production of lead and silver in the State, a record held by the Yreka district in 1919. Most of the output of the district came from the Hecla and Hercules properties. The Hecla mine was operated for 289 days and the mill for 265 days. Ore and concentrate at the rate of about 2,200 tons a month were shipped to the Bunker Hill smelter, at Bradley. According to the figures given to the assessor, 208,906 tons of ore was extracted, having a gross value of $2,202,963. The cost of extraction was $952,791, freight and treatment $510,456, betterment and repairs $64,859, and net profit $674,857. The following extracts are taken from the printed report [19] of the company:

[19] Hecla Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

A total of 4,449 feet of development work was performed during the year, 2,952 feet of drifts and 1,497 feet of crosscuts and raises.

The principal piece of development for the year was done on the 2,000-foot level. In December the ore on this level was encountered at approximately the same point at which it was found on the level above (1,600-foot level). The quantity and quality of the ore is good and the development so far is in every way satisfactory.

Production for the year was much less than for the two years preceding. Output was purposely low part of the year because of surplus lead stocks, and a strike of workmen for higher wages cut production entirely for a period of over 60 days.

Our ore reserves are estimated at 1,549,833 tons, without including any tonnage between 2,000 and 1,600 foot levels. There is not sufficient development on the 2,000-foot level on which to base an estimate. We expect, however, from present appearances that this level will add about 750,000 tons to our reserves.

Dividends for the year were $600,000, and total dividends to the end of the period are $7,855,000.

Our total taxes for income and excess profits for 1917 and 1918 are not yet fixed. We have made payments for each of these years but await the decision of the Internal Revenue Department before the total sum to be paid can be made known.

Shareholders have been advised through a circular letter that suit has been brought by the Federal Mining & Smelting Co. for possession of our east ore body. * * *

Of the ore mined 175,102 tons was milled, making 19,746 tons of concentrate. This, with 7,433 tons of crude ore, was smelted and contained 795,058 ounces of silver and 24,726,015 pounds of lead.

The production of the Hecla Mining Co. for 16 years was 415,126 tons of crude ore and concentrate, containing 12,010,134 ounces of silver, 413,878,303 pounds of lead, and 941,229 pounds of gross zinc.

A statement to stockholders gives the following information regarding the apex suit:

In reply to inquiries as to threatened litigation we wish to advise you that on November 22, 1919, we were served with notice of suit filed by the Federal Mining & Smelting Co., alleging that we have mined and taken out ores belonging to them by virtue of apexing in the Russel lode mining claim. This claim is owned by the Federal and is under lease by them to the Marsh Mines Consolidated. Our answer to their complaint will be made only in court at the proper time. We may state, however, that the ore involved is only what is known as our East ore body and can not affect the main ore body nor the Ore-or-No-Go, and that all ore mined by us has been taken from within our own lines.

The Hercules mine, one of the largest mines of the State, was operated only 170 days during the year. Crude lead ore and concentrate were shipped to various smelting plants, principally to the one at Northport, Wash. The statement to the county assessor gave 17,800 tons of crude ore and concentrates shipped, which had a gross value of $1,611,153. The cost of extraction was $736,023, freight and treatment $652,482, betterment and repairs $3,131, and net profits $219,517. Dividends if distributed were not published. The deepest work in the mine is 800 feet below the Hummingbird or No. 5 tunnel, 2,500 feet below the apex of the vein. Since the first shipments in 1901 the mine has produced about 25,000,000 ounces of silver, 600,000,000 pounds of lead, and some zinc, copper, and gold. The years of greatest output were 1916 and 1917, and some of the richest ore was mined in 1901. It averaged 132.13 ounces of silver to the ton and 59.84 per cent of lead. The output by years to 1916 is given by Weed.[20] The company operates a concentration plant at Wallace and owns an interest in the lead plant of the Northport Smelting & Refining Co., at Northport, Wash., which was active only four months of the year, and an interest in the Pennsylvania

[20] Weed, W. H., Mines Handbook, vol. 14, p. 703, 1920.

Smelting Co., at Carnegie, Pa., where the lead bullion from Northport is refined.

The Frisco mine, owned by the Federal Mining & Smelting Co., produced sulphide lead ore and zinc ore of shipping grade. The statement to the county assessor gave 1,615 tons of ore extracted, valued at $97,778. The cost of extraction was $54,751, freight and treatment $33,956, and net profits $9,071. Sulphide lead ore was also shipped from mines at Mace and Burke owned by the Federal Mining & Smelting Co. Figures to the assessor gave 2,423 tons of ore extracted, which had a gross value of $144,855. The cost of extraction was $97,080, and freight and treatment $48,624. The profit from the Burke mines was $2,776, and the loss at the Mace mines was $3,625. Several shipments of concentrate resulted from the treatment of creek tailings.

The Marsh Mines Consolidated did some drifting on a vein on the Russel claim, under lease until 1926 from the Federal Mining & Smelting Co. As this vein is supposed to dip into ground owned by the Hecla Co., the Marsh Co. is involved in the suit between the Federal and Hecla companies.[21]

Placer Center district (*Sunset*).—Four deep mines produced 62,271 tons of ore, containing $1,450 in gold, 406,117 ounces of silver, 42,047 pounds of copper, 11,974,603 pounds of lead and 375,985 pounds of recoverable zinc, valued in all at $1,126,223, or an average of $18.09 a ton. Of the total ore output, 2,853 tons was shipped as first-class ore and 59,418 tons was concentrated, making 12,356 tons of concentrates. Eight deep mines in 1918 produced 139,975 tons of ore, valued at $2,883,706. The largest production was that of the Tamarack & Custer Consolidated Mining Co., which operated the mine for approximately six months. Crude ore and concentrate were shipped to Northport during the period of operation. The showing of ore at the lowest level is most encouraging. According to the statement to the assessor 14,121 tons of crude ore and concentrates was shipped, which had a total value of $1,044,753. The cost of extraction was $430,427, freight and treatment $370,350, betterment and repairs $22,546, and net profit $221,430. Dividends amounted to $52,288.

Lead ore was shipped from the Rex mine, near Sunset, and a fair quantity of both crude ore and concentrate was shipped from the Success property. Several hundred tons of zinc concentrate was shipped East for smelting, but the output was comparatively small, as the expense of freight and treatment was prohibitive. In the Ruth property 379 feet of drifting was done.

St. Joe district (*Falcon*).—More than 1,000 tons of oxidized copper ore was shipped from the Richmond mine, though the property was not operated the entire year. The shaft was sunk 200 feet, and drifts were run at the 450-foot and 500-foot levels, where sulphide ore was encountered. A long lower adit was being driven in the Monitor mine, owned by the Montana Idaho Copper Co., and work in 1919 consisted of 1,151 feet in crosscut and drift.

Summit district (*Murray*).—Lead ore and concentrate were shipped from the Monarch mine, operated by the Fidelity Co. (Ltd.). In

[21] Eng. and Min. Jour., vol. 109, p. 284, 1920.

1918 the value of the district output was $9,527. Development work at the Giant Ledge property consisted of 800 feet of drifting.

Yreka district (Kellogg).—Ten mines in the Yreka district produced 580,123 tons of ore, containing $8,624 in gold, 1,838,951 ounces of silver, 268,735 pounds of copper, 74,885,982 pounds of lead, and 12,000 pounds of zinc, valued in all at $6,088,066, or an average of $10.49 a ton. The output was divided into 408,595 tons of ore, which, with 155,083 tons of old tailings, was concentrated, and 16,445 tons of first-class ore. Sixteen deep mines in 1918 produced 551,128 tons of ore, valued at $8,552,016. The mines of the district were not seriously affected by the labor strike in August and consequently produced more silver and lead than any other district in the State. The Bunker Hill & Sullivan Mining & Concentrating Co. operated its mine and mills during the entire year and made the largest production of lead in the State. Concentrate was shipped to the Bunker Hill smelter and to various plants of the American Smelting & Refining Co. The statement to the county assessor gave 393,698 tons of ore extracted, having a gross value of $5,093,826. The cost of extraction was $1,498,704, freight and treatment $1,731,634, betterment and repairs $511,875, and net profit $1,396,496. Dividends paid in 1919 amounted to $1,144,500, and dividends to date to $23,231,250. The printed report [22] issued by the company is one of exceptional value as it gives in unusual detail the cost of mining and milling, a summary of operations since May, 1886, and maps of the property. Extracts from this report follow:

Production for 1919 is closely the same as that for 1918, as the same conditions of labor shortage which caused the decrease of production during 1918, especially during the summer months, was responsible for a similar decrease of 1919 output. However, the lower prices paid for the metals resulted in a substantial lower profit being obtained from the operations. Costs of operations for the past two years are closely the same, and are, for reasons applying universally to all our industries, much higher than in former years.

Production from the mine and the operations of our entire enterprise were uninterrupted throughout the year. * * *

Conditions have made the usual extensive development program impossible of carrying out during the year just closed, but the moderate amount of development conducted on No. 15 level, the bottom level of the mine, has been extraordinarily successful in exposing a large tonnage of high-grade ore equal in richness and purity to anything heretofore known in the 35 years of mining done in the district. The extension of the mine workings in the Stemwinder and Sullivan mines has also exposed additional ore, more than equalling that removed during the year.

We have ore blocked out to date ready for extraction, 21,771 tons in the Stemwinder mine, 167,905 tons in the Sullivan mine, and 4,927,262 tons in the Bunker Hill mine, making a total of 5,116,938 tons. * * *

The mine was in operation for the full period of 12 months and produced 393,698 tons of concentrating ore at a cost of $1,135,862.45. * * *

Two hundred eighty-six feet of raises were driven at a cost of $8,984.91. * * *

The small amount of development work for the years 1918 and 1919 was in the nature of a war sacrifice. As development of the mine was already far in advance, and, as labor was scarce and production important, efforts were directed solely toward increasing the production. * * *

The West Mill concentrators were in operation for the full year, during which 35⅓ days were lost. * * *

During the year 393,698 tons of mine ore were concentrated, making the average work of the concentrators 1,078 tons per day, or say 1,194 tons per 24 hours of actual operation, at a cost of $296,166.53. * * *

[22] Bunker Hill & Sullivan Mining & Concentrating Co. Thirty-second Ann. Rept., for year ending Dec. 31, 1919.

The Sweeney mill was operated on tailings during the year, treating 86,925 tons at a total cost of $45,998.77; 4,990.58 tons of concentrates were produced, the gross value of which is included in the production tables of this report.

The ore milled, 480,623 tons, contained 8.32 per cent of lead and 2.86 ounces of silver to the ton. From this ore, 82,662 tons of concentrates and middlings was produced, containing 65,545,917 pounds of lead and 1,107,212 ounces of silver. The loss in tailings was 15.32 per cent of the lead and 22.54 per cent of the silver in ore milled, or a total of 17.11 per cent. The total cost per pound of lead was 4.94 cents. From 1886 to 1919 the company has mined 8,756,536 tons of ore having a gross value of $91,435,484. Net smelter returns were $53,759,161, and operating profit was $30,627,611. An interesting series of articles by Rickard,[23] gives the history of the Bunker Hill mine, a discussion of the geology of the property, and the milling practice at the different plants.

The Bunker Hill smelter and refinery continued active operations in 1919 but not at full capacity. After March 1, 1919, one blast furnace was sufficient to smelt all the ore received from outside sources as well as ore from the Bunker Hill and allied mines. Receipts of custom ore were cut off by a strike of workmen at other mines in the Coeur d'Alene district, which closed them from August 15 to October 9. In March 5,000 tons of pig lead was said to be in stock. This was later disposed of, and in November the company was making every effort to expand the custom smelting business.

The Sweeney mill, formerly operated by the Federal Mining & Smelting Co. on ore from the Last Chance mine, is now owned and operated by the Bunker Hill Co. The superintendent gives the following description[24] of improvements:

> The 1,000-ton test indicated that treatment of the tailing was commercially practicable, so the plant was remodeled for convenient handling of the tailing as well as ore from lessees' operations in the old Last Chance mine workings. The changes consisted in the installation of 11 Wilfley tables on the floor that used to contain the fine jigs; a drag under the 3-millimeters trommels to carry the undersize to the 20-mesh trommels; Calumet classifiers to classify the undersize of the 20-mesh trommels for table-feed; and a flotation plant on the west side of the coarse-jig floor. The flotation plant consists of three Bunker Hill and two Callow cells, it takes its feed from a 30 by 8 foot Dorr thickener, which is on the ground west of the mill. The feed to the Dorr thickener is the overflow of the Calumet classifiers. Some of the rolls and the methods of feeding them have been somewhat changed. The coarse jigs, elevators, and Huntington mills were not materially altered.
>
> The remodeled mill dresses 400 tons of tailing from the old dump in 16 hours, or it can concentrate 200 tons of lessees' ore in the same period. The old dump-tailing assays 1¾ per cent lead. While operating on this tailing two valuable products are made. First, a middling that is taken off the jigs and tables assaying 10 per cent lead, 4 ounces silver, and more than 20 per cent excess of iron over silica, for which reason it is especially desired by the smelter for fluxing. The second product is the flotation concentrate, which assays 25 per cent lead and 18 ounces of silver per ton.

At the Caledonia property production continued but at a greatly reduced rate. Development consisted of 350 feet of drifts and shipments of lead ore, containing considerable silver, were made at the rate of about 1,200 tons a month. According to the statement to the assessor, 15,225 tons of ore was extracted, having a gross value of $785,213. The cost of extraction was $67,760, freight and treatment $230,219, and net profit $487,234. A recent report[25] gave a

[23] Rickard, T. A., The Bunker Hill enterprise: Min. and Sci. Press, Jan. 3, 1920, p. 5, etc.
[24] Handy, R. S., The Sweeney mill at Kellogg, Idaho: Min. and Sci. Press, Apr. 12, 1919, p. 504.
[25] Caledonia Mining Co. statement to stockholders, Feb. 5, 1920.

production from 15,225 tons of ore of 507,862 ounces of silver, 55,999 pounds of copper, and 4,224,054 pounds of lead. Dividends paid in 1919 amounted to $312,600. The report says:

> Since my last statement of July 23, 1919, there has been a decline in the production of your property and a corresponding decrease in the net profits shown for the last six months as compared with former similar periods. Payments on account of Federal income and excess profits taxes are included in the figures shown, but as pointed out in my last statement are subject to possible review. Development is under way on the Keating tunnel level, but so far without disclosing new ore. By further drawing on the surplus the present dividend rate of 1 cent per share per month will be continued for the present, but during the coming spring or summer it will doubtless become necessary to revise the practice of paying this same rate monthly and make such payment every two or possibly three months.

Several thousand tons of crude lead ore and concentrate was shipped from the Sierra Nevada property to the Bunker Hill smelter. According to the statement to the assessor, 14,820 tons of ore was extracted, having a gross value of $282,715. The cost of extraction was $82,716, freight and treatment $91,348, and net profit $108,651. A large production of lead concentrate resulted from the treatment of old tailings by the Mullan Milling Co. and the Thornsdon Metal Saving Co. The Stewart Mining Co., formerly a large producer, was practically idle. A 75-ton flotation plant was operated by the Hayes Co., and a large quantity of old tailings re-treated. At the Alhambra property the work consisted of 910 feet of drifting and 421 feet of crosscutting. A 50-ton mill equipped for flotation was used experimentally. The Big Creek Mining Co. shipped several hundred tons of sulphide lead ore and some silver ore, containing copper. A concentration plant was being constructed in November.

The mines of the Pine Creek section of the Yreka district [26] did not produce in 1919, as the railroad into the district has never been completed. Several properties such as the Highland Surprise, Constitution, Douglas, Nabob, and Denver mines are in a position to ship ore if the conditions of transportation are improved. At the Nabob mine a 150-ton mill was being constructed for the concentration of the ore and 316 feet of work was done in drifts and raises.

VALLEY COUNTY.

Lake City district.—A small output of placer gold was mined in the vicinity of McCall.

Thunder Mountain district.—Sluicing the surface rock at the old Dewey mine resulted in the shipment of some bullion, containing gold and silver.

WASHINGTON COUNTY.

The Egan property, in the Washington district, near Mineral Siding, Oreg., became an important producer of sulphide copper ore containing considerable silver. Development work during the year consisted of 190 feet of raises and 510 feet of drifts and crosscuts. The Enterprise claim in the same locality produced ore containing silver and copper. At the I. X. L. mine, in the Heath district, 700 feet of crosscuts and drifts was driven. The property was described in a State publication.[27]

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[26] Jones, E. L., jr., A reconnaissance of the Pine Creek district, Idaho: U. S. Geol. Survey Bull. 710, pp. 1–36, 1919. (Includes descriptions of geology and ore deposits.)

[27] Livingston, D. C., and Laney, F. B., the copper deposits of the Seven Devils and adjacent districts: Idaho Bur. Mines and Geology Bull. 1, p. 83, 1920.

GOLD, SILVER, COPPER, AND LEAD IN WASHINGTON.[1]

(MINES REPORT.)

By C. N. Gerry.

PRODUCTION.

SUMMARY.

The value of the mine production of gold, silver, copper, and lead in Washington in 1919 decreased nearly 34 per cent from that of 1918. The output of the four metals decreased, and the decrease in copper and lead was considerable.

One company paid dividends which aggregated $47,625 in 1919, but these were paid from the earnings of past years.

Mine production of gold, silver, copper, lead, and zinc in Washington in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	84	138,911	$304,658	310,093	1,922,406	5,271,815	38,873	$1,467,421
1919	49	100,879	252,862	259,384	1,676,576	2,146,157	.....	968,961
Decrease, 1919	35	38,032	51,796	50,709	245,830	3,125,658	38,873	498,460
Total, 1860–1919	.....	.....	28,006,212	7,622,917	14,521,782	34,675,076	3,193,670	38,923,048

ORE.

The quantity of ore sold or treated in 1919 decreased more than 27 per cent. The output from Snohomish County increased slightly, but that of Ferry and Stevens counties was much less. The average value per ton of the ore decreased from $10.54 in 1918 to $9.59 in 1919, but the value per ton in gold and silver increased from $4.40 to $5.37. Of the total output of ore, nearly 29 per cent was dry or siliceous ore, nearly 68 per cent copper ore, and more than 3 per cent lead ore. No shipments of zinc ore or lead-zinc ore were made, but there were a few shipments of copper-lead ore. The siliceous ore averaged $12.58 in gold and silver to the ton; the copper ore, $2.45; the lead ore, $1.80; and the copper-lead ore, $38.77.

The siliceous ore was composed of 25,648 tons of gold ore, averaging per ton $9.61 in gold, 2.52 ounces of silver, and a trace of copper; and

[1] The figures of production used in this report were tabulated and the statistical tables compiled by B. N. Patchell, of the United States Geological Survey.

3,438 tons of silver ore, averaging per ton 39 cents in gold and 11.75 ounces of silver. Sulphide iron ore, containing gold and silver, was formerly shipped from Ferry County, but no shipments were made in 1919. The total siliceous ore averaged per ton $8.64 in gold, 3.61 ounces of silver, and a trace of copper and lead. Copper ore as mined averaged 5 cents in gold and 2.15 ounces of silver to the ton and 1.22 per cent of copper, or a total value per ton of $6.99. Lead ore averaged 1 cent in gold and 1.60 ounces of silver to the ton and 32.29 per cent of lead, or a total value per ton of $36.09. Copper-lead ore averaged 11 cents in gold and 34.52 ounces of silver to the ton, 3.10 per cent of copper, and 20.86 per cent of lead, or a total value of $72.40 a ton. Nearly all the lead ore and most of the siliceous ore was shipped without treatment, but most of the copper ore was concentrated.

Ore and metals produced in Washington in 1919.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Placers	7	.....	60.32	18	.....	.....
Dry or siliceous ore	19	29,086	12,016.93	104,980	2,463	143
Copper ore	13	68,447	153.01	146,891	1,669,060	.....
Lead ore	8	3,281	1.60	5,251	1,028	2,118,886
Copper-lead ore	2	65	.34	2,244	4,025	27,128
	.....	100,879	12,232.20	259,384	1,676,576	2,146,157

Ore sold or treated from Washington in 1919, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Chelan	5	.....	.....	.....	5
Ferry	25,598	99	.....	.....	25,697
King	66	.....	.....	.....	66
Lewis	.....	17	.....	.....	17
Okanogan	2,752	.....	158	65	2,975
Pend Oreille	15	.....	.....	.....	15
Pierce	.....	24	.....	.....	24
Snohomish	.....	12,761	.....	.....	12,761
Stevens	650	55,546	3,123	.....	59,319
	[a] 29,086	68,447	3,281	65	100,879
Average value per ton in gold and silver	$12.58	$2.45	$1.80	$38.77	$5.37

[a] Includes 25,648 tons of gold ore and 3,438 tons of silver ore.

Eight milling plants were active in 1919; all used concentration equipment of various types, and four were equipped with flotation machines. The largest milling operation was that of the United Silver-Copper plant, at Chewelah, and a large output was also treated in the Index district of Snohomish County. A cyanidation plant was being constructed for the Consolidated Mines Co., in the Springdale district, Stevens County, but no milling was done at Republic.

Most of the ore from mines in Washington was smelted at Tacoma and Northport, Wash., and Trail, British Columbia. The copper

plant at Greenwood, British Columbia, was idle, and the Granby plant at Grand Forks, British Columbia, was closed in June. The Tacoma smelter was operated continuously but not at full capacity, and the lead plant at Northport produced about one-third of the normal output of bullion. As in other regions, smelting operations were at a low ebb in 1919. The plant at Trail, British Columbia, is unusually complete, as it has facilities for milling and smelting copper and lead ore, an electrolytic plant for zinc ore, and electrolytic refineries for copper and lead. The improvements were described in a recent publication.[2] Late in the year few shipments were made to the Canadian plants, as the rate of exchange was unfavorable for exportation.

In past years much of the ore mined in Washington was treated by amalgamation or cyanidation, but practically all ore was concentrated or smelted in 1919. No mercury or cyanide was consumed, except that used in small milling tests.

More than 69 per cent of the output of ore, or 70,054 tons, was concentrated, a decrease from 72,951 tons in 1918. The concentrates decreased from 4,234 tons to 3,936 tons. The greater part was copper concentrate from the Chewelah district, in Stevens County, and the Index district, in Snohomish County, with a small quantity from Okanogan County. Siliceous concentrates averaged $7.99 in gold and 164.77 ounces of silver to the ton and 0.31 per cent of copper and had an average value per ton of $193.67. Copper concentrates averaged 67 cents in gold and 24.69 ounces of silver to the ton and 18.36 per cent of copper and had an average value per ton of $96.60. Lead concentrates averaged 21 cents in gold and 63.73 ounces of silver to the ton, 0.92 per cent of copper, and 49.33 per cent of lead, and had an average value of $127.29 a ton.

Mine production of metals from Washington concentrates in 1919.

By counties.

County.	Ore to concentrating mills.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Total value of concentrates.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Okanogan	2,876	160	51.00	24,199	1,498	28,698	$29,957
Snohomish	12,645	843	74.00	6,401	530,164	.....	107,308
Stevens	54,533	2,933	47.86	87,247	846,096	26,551	257,488
	70,054	3,936	172.86	117,847	1,377,758	55,249	394,753

By kinds of concentrates.

Dry or siliceous	.....	132	51.00	21,749	809	.....	$25,564
Copper	.....	3,748	121.29	92,529	1,375,921	.....	362,061
Lead	.....	56	.57	3,569	1,028	55,249	7,128

Nearly 31 per cent of the ore, or 30,818 tons, was mined and shipped directly to smelters, a decrease from 64,938 tons in 1918. The greatest quantity of this ore came from Ferry County, and a

[2] Mason, F. H., Recent metallurgy at Trail, B. C.; Min. and Sci. Press, May 12, 1920, p. 863.

large tonnage came from Stevens County. Of the first-class or shipping ore, about 85 per cent was dry or siliceous, nearly 5 per cent was copper ore, and nearly 10 per cent was lead ore. The siliceous ore shipped to smelters averaged $9.39 in gold, 3.16 ounces of silver, and 0.06 pound of copper to the ton and was valued at $12.94 a ton. Copper ore shipped averaged 44 cents in gold and 36.41 ounces of silver to the ton and 9.82 per cent of copper and was valued at $77.74 a ton. First-class lead ore shipped had an average assay of 0.7 cent in gold and 0.58 ounce of silver to the ton and 35.37 per cent of lead and was valued at $38.15 a ton.

Most of the copper ore shipped, or 1,469 tons, was sulphide and contained 45 cents in gold and 37.01 ounces of silver to the ton and 9.87 per cent of copper. The sulphide lead ore shipped amounted to 267 tons and contained 8 cents in gold and 2.97 ounces of silver to the ton and 52.39 per cent of lead. The copper-lead ore was sulphide. The oxidized copper ore (24 tons) averaged 6.82 per cent of copper, and the oxidized or carbonate lead ore (2,650 tons) averaged 0.34 ounce of silver to the ton and 33.66 per cent of lead.

Mine production of metals from Washington crude ore shipped to smelters in 1919.

By counties.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Ferry	25,697	11,858.70	65,684	5,313	143	$319,703
King	66	89.80	1,060	489	.....	3,134
Lewis	17	1.90	28	2,418	.....	520
Okanogan	97	5.04	4,692	4,025	30,573	7,729
Pend Oreille	15	4.84	288	399	.....	497
Pierce	24	.....	.....	3,275	.....	609
Snohomish	116	11.70	451	19,624	.....	4,398
Stevens	4,786	21.53	69,315	263,275	2,060,192	236,237
	30,818	11,993.51	141,518	298,818	2,090,908	572,827

By kinds of ore.

Dry or siliceous	26,343	11,960.43	83,230	1,654	143	$340,778
Copper	1,493	31.74	54,362	293,139	.....	116,065
Lead	2,917	1.00	1,682	.....	2,063,637	111,278
Copper-lead	65	.34	2,244	4,025	27,128	4,706

GOLD.

The mine production of gold in Washington was valued at $252,862, against $304,658 in 1918. Of this total, 98 per cent was obtained from ores shipped directly to smelters, less than 1 per cent from placers, and more than 1 per cent from concentrates. The table below shows that siliceous ore supplied most of the gold and that copper ore contained only about 1 per cent of the total. Gold recovered from siliceous ores decreased 2,090.43 ounces. Nearly all the gold was produced by four mines at Republic—the Quilp, Last Chance, Knob Hill, and San Poil. The Northport Smelting & Refining Co. made only a few shipments from the Surprise-Lone Pine-Pearl group, formerly a large producer, and the Boundary Red Mountain mine, in Whatcom County, the largest producer of gold in 1917, was idle

in 1919. Resumption of work at the Quilp mine after an idleness of many years was the most interesting feature of the mining industry, especially as many of the gold mines of the State have been closed on account of excessive costs.

Mine production of gold in Washington in 1919, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Chelan	3.43	3.10				6.53
Ferry		11,858.70				11,858.70
King		89.78				89.78
Kittitas	47.07					47.07
Lewis			1.89			1.89
Okanogan	8.66	57.19		1.00	0.34	67.19
Pend Oreille		4.84				4.84
Snohomish	1.16		85.67			86.83
Stevens		3.32	65.45	.60		69.37
	60.32	[a] 12,016.93	153.01	1.60	.34	12,232.20

[a] Includes 11,951.91 ounces from gold ore and 65.02 ounces from silver ore.

SILVER.

The mine production of silver decreased from 310,093 ounces, valued at $310,093, in 1918, to 259,384 ounces, valued at $290,510, in 1919, a decrease of more than 16 per cent in quantity and $19,583 in value. Stevens County had the largest production, and Ferry and Okanogan counties followed. Crude ore shipped to smelters supplied nearly 55 per cent of the total silver, and concentrates about 45 per cent; the output from placers and mill bullion was small. Copper ore contained nearly 57 per cent of the silver, siliceous ore more than 40 per cent, lead ore 2 per cent, and copper-lead ore less than 1 per cent. The following five mines produced nearly 85 per cent of the total silver of Washington: United Silver-Copper, Last Chance, Quilp, Apache, and Consolidated Mines Co.

Mine production of silver in Washington in 1919, in fine ounces.

County.	Placers.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Chelan	1	1				2
Ferry		65,240	444			65,684
King		1,060				1,060
Kittitas	15					15
Lewis			28			28
Okanogan	2	23,705		2,942	2,244	28,893
Pend Oreille		288				288
Snohomish			6,852			6,852
Stevens		14,686	139,567	2,309		156,562
	18	[a] 104,980	146,891	5,251	2,244	259,384

[a] Includes 64,578 ounces from gold ore and 40,402 ounces from silver ore.

COPPER.

The mine production of copper decreased nearly 13 per cent, from 1,922,406 pounds, valued at $474,834, in 1918 to 1,676,576 pounds, valued at $311,843, in 1919. The production increased in Snohomish

County, but decreased considerably in Stevens, Okanogan, and Ferry counties. Crude ore yielded nearly 18 per cent of the copper and concentrates more than 82 per cent. Most of the metal was obtained from copper ore, and four mines produced nearly 96 per cent of the total. In the order of their output, they were the United Silver-Copper, Sunset, Loon Lake, and Reardon mines.

Mine production of copper in Washington in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Total.
Ferry	766	4,547	.....	.....	5,313
King	489	.....	.....	.....	489
Lewis	.....	2,418	.....	.....	2,418
Okanogan	809	.....	689	4,025	5,523
Pend Oreille	399	.....	.....	.....	399
Pierce	.....	3,275	.....	.....	3,275
Snohomish	.....	549,788	.....	.....	549,788
Stevens	.....	1,109,032	339	.....	1,109,371
	[a] 2,463	1,669,060	1,028	4,025	1,676,576

[a] Includes 1,255 pounds from gold ore and 1,208 pounds from silver ore.

LEAD.

The mine production of lead in 1919 decreased more than 59 per cent, from 5,271,815 pounds, valued at $374,299, in 1918 to 2,146,157 pounds, valued at $113,746, in 1919. Most of the lead came from the Northport district, of Stevens County, and more than 97 per cent of it came from crude ore shipped to smelters. Of the first-class ore shipped to smelters, 2,650 tons was carbonate containing 1,783,885 pounds of lead and 267 tons was sulphide containing 279,752 pounds of lead. The Electric Point mine was the only large producer of lead ore.

ZINC.

No zinc ore was treated or marketed in Washington in 1919. In 1918 the output of recoverable zinc was 38,873 pounds, and in 1917 it was 1,195,567 pounds. Mines in the Metaline and Northport districts, producers of zinc in past years, were idle in 1919.

MINING INDUSTRY.

The mining companies of Washington experienced an unusually quiet year during 1919. Judged from the metal output, it was the poorest year since 1915. The mines produced metals valued at more than $2,000,000 in both 1916 and 1917, but the output for 1919 was valued at slightly less than $1,000,000 as a result of excessive expenses, combined with a decrease in metal prices (except silver), a poor market for copper ore and lead ore, and difficulty in securing efficient labor, especially during the early part of the year. Smelting was continued at both Tacoma and Northport at a greatly reduced rate, and most of the ore for these plants was obtained from sources outside of the State. Fewer mines were active, but several of the larger properties were worked and milling plants constructed in spite of adverse conditions.

Mine production of gold, silver, copper, and lead in Washington in 1919.

County.	Ore.	Gold.		Silver.	
		Quantity.	Value.	Quantity.	Value.
	Short tons.	*Fine ounces.*		*Fine ounces.*	
Chelan	5	6.53	$135	2	$2
Ferry	25,697	11,858.70	245,141	65,684	73,566
King	66	89.78	1,856	1,060	1,187
Kittitas	.....	47.07	973	15	17
Lewis	17	1.89	39	28	31
Okanogan	2,975	67.19	1,389	28,893	32,360
Pend Oreille	15	4.84	100	288	323
Pierce	24	.....	.....	.....	.....
Snohomish	12,761	86.83	1,795	6,852	7,674
Stevens	59,319	69.37	1,434	156,562	175,350
	100,879	12,232.20	252,862	259,384	290,510

County.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
Chelan	.....	.....	.....	.....	$137
Ferry	5,313	$988	143	$8	319,703
King	489	91	.....	.....	3,134
Kittitas	.....	.....	.....	.....	990
Lewis	2,418	450	.....	.....	520
Okanogan	5,523	1,027	59,271	3,141	37,917
Pend Oreille	399	74	.....	.....	497
Pierce	3,275	609	.....	.....	609
Snohomish	549,788	102,261	.....	.....	111,730
Stevens	1,109,371	206,343	2,086,743	110,597	493,724
	1,676,576	311,843	2,146,157	113,746	968,961

Ore sold or treated, deep mines producing, and average value of ores in Washington in 1918 and 1919.

County.	Ore sold or treated, 1919.		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	Quantity.	Increase or decrease.	1918	1919	1918	1919	1918	1919
	Short tons.	*Short tons.*						
Chelan	5	+ 4	1	1	$151.00	$13.00	$151.00	$13.00
Ferry	25,697	−21,818	16	9	8.61	12.44	7.94	12.40
King	66	− 104	1	1	41.11	47.49	41.11	46.11
Lewis	17	− 7	1	1	20.71	30.59	.....	4.12
Okanogan	2,975	− 617	18	9	21.02	12.68	9.30	11.28
Pend Oreille	15	− 258	5	1	64.97	33.13	1.45	28.20
Pierce	24	+ 24	.....	1	.....	25.37	.....	.....
Snohomish	12,761	+ 613	7	4	9.68	8.75	.49	.74
Stevens	59,319	−14,913	23	15	11.13	8.32	2.38	2.98
Whatcom	.....	− 956	2	.....	10.49	.....	10.49	.....
	100,879	−38,032	74	42	10.54	9.59	4.40	5.37

[a] Placer product excluded.

Seven placers operated by hydraulic and sluicing methods were active in 1919. Of the 42 deep mines, 14 produced gold and silver; 13, gold, silver, and copper; 5, silver and lead; 3, silver and copper; 2, gold, silver, and lead; 2, silver, copper, and lead; 1, gold; 1, copper; and 1, gold, silver, copper, and lead.

REVIEW BY COUNTIES.

CHELAN COUNTY.

The mines of Chelan County were unproductive, except for a small shipment of gold bullion from the Cook mine, in the Chelan Lake district, and from a placer property near Blewett.

FERRY COUNTY.

Mine production in Ferry County, Wash., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	16	47,515	$276,066	101,376	127,813	.....	$409,012
1919	9	25,697	245,141	65,684	5,313	143	319,703
Increase or decrease, 1919	−7	−21,818	−30,925	−35,692	−122,500	+143	−89,309

The quantity of ore mined and the value of metals produced in Ferry County decreased considerably in 1919. The value of the ore, however, increased from $8.61 to $12.44 a ton. The entire output, having a value of $319,703, was shipped directly to smelters. Of the total output, 25,598 tons was siliceous ore and 99 tons was copper ore. Ferry County produced nearly 97 per cent of the gold of the State, more than 25 per cent of the silver, but less than 1 per cent of the copper.

Belcher district.—The Laurier mine was leased, and a few shipments of sulphide copper ore from it were sent to Trail, British Columbia. No iron ore was shipped from the Belcher property.

Danville district.—A shipment of sulphide ore containing gold and silver was made from the Virginia mine, operated by the Chatterboy Mining Co. Production in the Danville district has decreased since 1916, when the mines produced 18,436 tons of ore, which was mostly low-grade copper ore. The La Fleur Mountain Mining Co. started work to develop ore containing gold, silver, and copper.

Enterprise district.—A shipment of silver ore was made from the Montana mine, near Meteor.

Keller district.—Though no shipments were made in 1919, development work was in progress, especially at the Addison and Walla Walla properties.

Republic district.—Six deep mines produced 25,537 tons of ore, containing gold valued at $244,730 and 63,479 ounces of silver, both valued at $315,827, or an average value per ton of $12.37. Eleven deep mines in 1918 produced 42,275 tons of ore valued at $369,769. No mills were operated in the district, and all the ore was shipped to smelters, most of it to Tacoma, Wash. From 1896 to the end of 1919 Republic district produced 536,855 tons of ore, containing $6,935,611 in gold and 2,039,797 ounces of silver, valued together at $8,169,262. After a long idleness work was resumed at the Quilp mine, an old producing property. Development was continued from the 600-foot to the 800-foot level, and ore shipped which had a value

in gold and silver of more than $100,000. The ratio of gold to silver is about 1 to 4, and the ore contains about 90 per cent of silica, which is valuable as a flux in smelting operations. The Quilp mine was the largest producer of gold in the State in 1919, and the Last Chance mine was second. Energetic mining was continued at the Last Chance mine from January to October, when the miners struck for higher wages and the smelters raised the treatment rate. Shipments for the year averaged about 800 tons a month, a larger output than that of any other mine in the district, though the grade of ore was somewhat lower. The shaft reached a depth of 650 feet, and stations were cut at this level and the 575-foot level. The Knob Hill Mining Co. was active for nearly 10 months of the year and shipped several thousand tons of ore valued at about $15 a ton. The expense of mining, freight, and smelting prevented the shipment of much low-grade ore from the district. The Northport Smelting & Refining Co. operated the Surprise-Lone Pine-Pearl and Blacktail mines for eight months of the year but shipped a comparatively small quantity of ore, as the company's smelter at Northport was idle the greater part of the year. Development work consisted of 616 feet of drifts and crosscuts. More than 2,000 tons of low-grade siliceous ore was shipped from the San Poil mine, owned by the Trail Mining & Smelting Co., of Trail, British Columbia. A few shipments were also made from the Ben Hur mine, under lease.

KING COUNTY.

Miller River district.—A few shipments of arsenical pyrite, which contained gold and silver, were made from the Apex mine.

KITTITAS COUNTY.

Swauk district.—Four placers near Liberty produced gold valued at $973 and 15 ounces of silver. The output has been steadily decreasing, and in 1919 no operations of importance were carried on.

LEWIS COUNTY.

Nisqually district.—A shipment of sulphide copper ore was made from the Eagle Peak property, near Ashford.

OKANOGAN COUNTY.

Nine deep mines and one placer in Okanogan County produced 2,975 tons of ore, which yielded $1,389 in gold, 28,893 ounces of silver, 5,523 pounds of copper, and 59,271 pounds of lead, valued in all at $37,917. The quantity of ore treated decreased, but the output of lead increased. The value of the ore decreased from $21.02 a ton in 1918 to $12.68 in 1919, but the value of the gold and silver increased from $9.30 to $11.28 a ton. Nearly all the ore, 2,876 tons, was concentrated and made 160 tons of concentrates. The ore was classified as 2,752 tons of siliceous ore, 158 tons of lead ore, and 65 tons of copper-lead ore.

Cascade district.—Some ore was milled by the Carey Mining & Milling Co., and a shipment of silver concentrates was made to Tacoma.

Conconully district.—The Arlington mine was idle most of the year, but a shipment of copper-lead ore was marketed by a lessee.

Moyers Creek district.—Many of the mines of the district were idle, but oxidized iron ore was shipped from the Neutral mine to Chewelah to be used in the manufacture of ferromagnesite.

Nespelem (Moses) district.—Four deep mines produced 2,676 tons of ore, containing $926 in gold, 21,188 ounces of silver, and 3,445 pounds of lead, in all valued at $24,840, or an average value of $9.28 a ton. Most of the ore was concentrated. The Great Metals Mining & Milling Co. operated a 100-ton milling plant on custom material. Low-grade silver ore was treated by flotation for the Apache Mining Co. and the Double Header mine. A shipment of lead ore was made from the Castle Creek mine, and one of silver ore from the Panama property.

Palmer Mountain district.—Ore from the Kaaba mine, near Oroville, was milled by the Bender Metals Milling Co., which treats custom ore at Nighthawk; and the Four Metals Mining Co. made a shipment of copper-lead ore. An aerial tramway was being erected for the Copper World Extension Co., which formerly shipped much copper ore. Development work was continued at the O. K. and Alice properties.

PEND OREILLE COUNTY.

The mines of the Metaline district, large producers in 1917, were idle in 1919. In the Newport district some work was done at the Eagle mine of the Ries Mining Co., and a small lot of ore containing gold, silver, and copper was shipped to the Northport smelter.

PIERCE COUNTY.

The Tacoma smelting plant was active throughout the year though at reduced capacity. Copper ore and siliceous ore from Alaska, Canada, Washington, and South America were treated by smelting and electrolytic refining. The tonnage from Washington is not large, but most of it, except the lead ore, was treated at this plant. From the Copper King mine, near Fairfax, a test shipment of copper ore was sent to Tacoma.

SNOHOMISH COUNTY.

Four deep mines and one placer in Snohomish County produced 12,761 tons of ore, $1,795 in gold, 6,852 ounces of silver, and 549,788 pounds of copper, valued in all at $111,730. This production represents an increase of 613 tons of ore but a decrease of $6,194 in total value. The entire output was copper ore, and most of it was milled. The value per ton decreased from $9.68 in 1918 to $8.75 in 1919.

Granite Falls district.—A small quantity of sulphide copper ore was shipped from the Wayside mine.

Index district.—The Sunset mine, 7 miles from Index, was operated about six months in 1919, and a large quantity of copper ore was milled in the plant, which uses concentration tables and flotation cells. Except the United Silver-Copper mine, at Chewelah, the Sunset was the largest shipper of copper concentrate in the State.

Stilaguamish district.—The M. N. R. Mining Co. operated the Bonanza Queen mine, near Silverton, and made a few shipments of sulphide copper ore.

STEVENS COUNTY.

Mine production in Stevens County, Wash., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	23	74,232	$8,199	168,669	1,170,488	5,077,152	$826,456
1919	15	59,319	1,434	156,562	1,109,371	2,086,743	493,724
Decrease, 1919	8	14,913	6,765	12,107	61,117	2,990,409	332,732

There was a general decrease in the output of metals in Stevens County in 1919. The value per ton decreased from $11.13 in 1918 to $8.32 in 1919, but the value in gold and silver increased from $2.38 to $2.98 a ton. Most of the ore, or 54,533 tons, was milled and yielded 2,933 tons of concentrates, valued at $257,488, or $87.79 a ton. The remainder, 4,786 tons, was shipped directly to the smelters and had a total value of $236,237, or $49.36 a ton. Of the total output, 55,546 tons was copper ore, 3,123 tons lead ore, and 650 tons siliceous ore.

Bossburg district.—Work at the Bonanza mine consisted mainly of drifting and cleaning out old stopes. One shipment of low-grade lead ore was marketed.

Chewelah district.—The United Silver-Copper Mining Co. was the only company which did important work in the Chewelah district. The mill treated a low-grade copper ore by table concentration and flotation, and crude ore of good grade was shipped without previous treatment. From 1901 to the end of 1919 the district has produced 317,886 tons of ore, yielding $70,491 in gold, 1,234,354 ounces of silver, 7,739,689 pounds of copper, and 265,139 pounds of lead, having a total value of $2,559,109. Three deep mines in 1918 produced 64,001 tons of ore, valued at $394,937, an average of $6.17 a ton. In 1919 the ore as mined was valued at $6.51 a ton, but most of it was concentrated. Crude ore shipped had an average value of $91.17 a ton, and concentrates $105.37. The following notes are taken from the printed annual report of the main producer: [3]

No profit was made during the year 1919. * * *

We sank the two-compartment shaft from the 1,100 to the 1,200 foot level. On this level we did about 900 feet of drifting, then a winze was sunk to the 1,400-foot level. While sinking this winze, we encountered a streak of very rich silver ore and when the 1,400-foot level was reached, a station was cut and drifting started north and south. The vein on this level is strong and well defined and carries good milling ore, but the high-grade streak which we followed down from the 1,200-foot level was very short, the total length being only 90 feet, and it was very irregular. While in some places it was 18 inches wide for a short distance, in others it would pinch down to a very narrow streak 4 to 6 inches wide. Some ore was shipped from this level, but as the ore had to be handled twice it made it very expensive. Up to now very little mining has been done on this level. The milling ore carries much better values in silver than the upper levels. The copper values are about the same. * * *

I have done a great deal of work in opening up the mine above the 1,000-foot level. All the old drifts, stopes, and different levels were cleaned out, retimbered, and the ground made safe. No. 1 tunnel was opened up and an ore bin constructed at the mouth of No. 1 tunnel. The hoisting station on the 400-foot level was overhauled and an air hoist installed. * * *

We are already feeling the labor shortage. We have been 25 to 30 men short for the past two weeks, but I believe I have solved this problem by going on the contract system. From now on all the ore will be mined by contract. * * *

[3] United Silver-Copper Mining Co. Fourteenth Ann. Rept., for year ending Dec. 31, 1919.

The power shortage has been one of the greatest handicaps to our company for several years past, and if it had not been for this shortage of power in 1918 and 1919, our company would have been able to pay off its indebtedness and insure a surplus by the end of the year 1919 in spite of all the other handicaps.

During the year 52,542 tons of ore was mined, 49,749 tons milled, and 746 tons shipped. The milling ore was reduced to 3,216 tons of concentrate. First-class ore and concentrate contained 133,061 ounces of silver and 922,227 pounds of copper, but the metals paid for by the smelting company were 126,408 ounces of silver and 830,996 pounds of copper. The operating expenses were $233,282; the net smelter returns, $208,565; and the loss, $24,717.

Loon Lake district.—The Loon Lake Copper Co. completed a 100-ton flotation plant in July and milled a large quantity of copper ore during five months. Copper concentrate of good grade, though low in gold and silver, was shipped to Trail, British Columbia. The plant consists of ball mills, classifiers, thickeners, flotation cells, and filter.

Northport district.—Four deep mines produced 2,857 tons of ore which yielded 1,123 ounces of silver and 2,053,697 pounds of lead, valued in all at $110,104, an average of $38.54 a ton. In 1918 the district produced 7,564 tons of ore, valued at $359,046, an average of $47.47 a ton. No mills were operated in the district, and all the ore was shipped to various smelting plants. The Electric Point Mining Co. produced most of the ore but experienced difficulty in finding a satisfactory market for its product. In January the smelting company at Trail, British Columbia, refused foreign ore, and shipments to Northport were reduced to a car a day. There was no output from the mine from February to August, when shipments to Midvale, Utah, were resumed. With the aid of the new tramway, regular shipments can be continued whenever market conditions warrant an increase. According to the financial statement,[4] the operating income for the year was $62,599, and the expenses, including those of depletion and depreciation, were $122,041. The operating loss was $55,242, but dividends of $47,625 were paid from past earnings.

The Northport Smelting & Refining Co. closed its smelting plant at Northport, Wash., in March, but continued operations in June, July, August, and December. Work on the drossing plant was continued, but shipments of bullion were reduced to one-third of the normal output as a result of the strike in the Coeur d'Alene district, Idaho, which supplies most of the ore.

Spokane Indian Reservation district.—Several shipments of copper ore were made from Davenport, Wash., by the O-Lo-Lim Copper Co.

Springdale district.—Five deep mines produced 1,062 tons of ore, $71 in gold, 15,855 ounces of silver, 28,489 pounds of copper, and 26,551 pounds of lead, valued in all at $24,535, an average of $23.10 a ton. Five mines in 1918 produced 1,780 tons of ore, valued at $41,829. The Turk mine produced a sulphide copper ore, and the Consolidated Mines Co. a siliceous silver ore. A cyanidation plant was being constructed for the Consolidated property.

WHATCOM COUNTY.

The Red Mountain property, near Sumas, a large producer in the past, was idle in 1919.

[4] Electric Point Mining Co. statement for year ending December 31, 1919.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN MONTANA.

(MINES REPORT.)

By C. N. Gerry.[1]

PRODUCTION.

GENERAL STATEMENT.

The value of the mine production of gold, silver, copper, lead, and zinc in Montana in 1919 decreased nearly 49 per cent from that of 1918, as shown in the accompanying table. The decrease was general and pronounced both in the quantity and value of all the metals and in the quantity of ore mined and treated. Silver Bow County, which includes the Butte or Summit Valley district, continued to produce the bulk of the silver, copper, lead, and zinc, though most of the gold was mined in other districts. Dividends declared by four mining companies in 1919 amounted to $11,100,991. The total for 1918 was $19,455,472, paid by six companies. Most of the dividends were paid by the Anaconda Copper Mining Co., assisted by its subsidiary companies. The surplus remaining after dividends were paid for 1919 was $62,011,125.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	493	7,823,967	$3,104,764	16,797,479	323,174,850	37,135,875	209,258,148	$121,405,569
1919	457	4,183,594	2,229,588	12,541,181	169,981,288	34,437,764	168,763,823	62,037,191
Decrease, 1919	36	3,640,373	875,176	4,256,298	153,193,562	2,698,111	40,494,325	59,368,378

[a] Includes placer production.

ORE.

The total quantity of ore sold or treated decreased more than 46 per cent, and the total average value per ton decreased from $15.47 in 1918 to $14.76 in 1919. The average value per ton of the gold and silver contained in this ore increased from $2.49 to $3.82. Nearly 74 per cent of the ore (3,089,433 tons) was concentrated, nearly 3 per cent (105,044 tons) was treated in gold and silver mills, and about 7 per cent (294,268 tons) was shipped directly to smelters.

[1] Reports were tabulated and statistical tables compiled by B. N. Patchell, of the United States Geological Survey.

The remainder, more than 16 per cent, consisted of ore leached and old tailings, which were shipped, concentrated, or cyanided. Mines in Silver Bow County produced 93 per cent of the total. Copper ore represented nearly 74 per cent of the total, lead-zinc ore more than 20 per cent, siliceous ore more than 5 per cent, and other kinds less than 1 per cent.

Of the total output of dry or siliceous ore 130,922 tons was classified as gold ore, 118 tons as gold and silver ore, and 90,646 tons as silver ore. There were 91,902 tons of dry or siliceous ore, together with 5,900 tons of old tailings, treated by cyanidation, and 13,142 tons treated by amalgamation. A large part, or 100,688 tons of siliceous ore and 9,446 tons of old tailings, was shipped directly to smelters for treatment, and 608 tons was treated at concentration mills. Lewis and Clark, Silver Bow, Fergus, and Granite counties were the largest producers of strictly siliceous ores. Deer Lodge County produced chiefly oxidized iron ore mined in the Georgetown district; it contained more than 20 per cent excess iron and a little gold and was used as a flux at the smelter. Sulphide iron ore containing considerable gold was produced in Madison County. The siliceous ore had an average assay per ton of $6 in gold, 7.70 ounces of silver, and a few pounds of copper and lead.

Of the output of copper ore 2,232,249 tons was of milling grade and produced 904,058 tons of concentrate averaging 29 cents in gold and 6.04 ounces of silver to the ton and 7.44 per cent of copper and having an average value of $34.73 a ton. The copper ore of shipping grade amounted to 172,472 tons, mostly sulphides, containing 43 cents in gold and 4.64 ounces of silver to the ton and 5.83 per cent of copper and having an average value of $27.33 a ton.

Of the output of lead ore 20,137 tons was shipped directly to the smelters. The first-class ore contained $3.30 in gold and 30.01 ounces of silver to the ton, 0 37 per cent of copper, and 11.41 per cent of lead and had an average value per ton of $50.39. Lead concentrates amounting to 12,126 tons were made from lead ore and lead-zinc ore and averaged $2.36 in gold and 28.61 ounces of silver to the ton, 0.16 per cent of copper, and 41.89 per cent of lead. The average value per ton of all lead concentrates was $79.42.

All the lead-zinc ore was milled and produced lead concentrate, zinc concentrate, and lead-zinc concentrate—the first item is given above.

Zinc concentrates recovered from lead-zinc ore aggregated 143,814 tons, averaging 60 cents in gold and 14.84 ounces of silver to the ton, 0.51 per cent of copper, 1.48 per cent of lead, and 45.66 per cent of zinc, with a total average value of $87.35 a ton. The lead-zinc concentrate aggregated 78,547 tons, containing $1.06 in gold and 16.73 ounces of silver to the ton, 1.56 per cent of copper, 9.06 per cent of lead, and 23.81 per cent of zinc; the average value was $69.95 a ton.

All the copper-lead-zinc ore was milled and produced 130 tons of copper-lead-zinc concentrate, containing $4.77 in gold and 41.12 ounces of silver to the ton, 4.31 per cent of copper, 8.96 per cent of lead, and 14.08 per cent of zinc; the average value was $96.90 a ton.

Ore and metals produced in Montana in 1919.

Source of production.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Placers	62	.....	14,097.92	2,309	.....	.....	.....
Dry or siliceous ore	262	221,686	64,289.55	1,707,053	396,501	140,694	.....
Copper ore	53	3,081,451	16,612.99	6,341,825	165,321,847	.....	.....
Lead ore	91	33,551	3,797.15	747,960	192,927	6,753,703	.....
Copper-lead ore	5	971	90.08	58,335	86,416	480,662	.....
Lead-zinc ore	9	845,549	8,938.64	3,678,353	3,972,397	27,039,405	168,727,223
Copper-lead-zinc ore	1	386	29.99	5,346	11,200	23,300	36,600
		4,183,594	107,856.32	12,541,181	169,981,288	34,437,764	168,763,823

Ore sold or treated in Montana in 1919, in short tons.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Copper-lead-zinc ore.	Total.
Beaverhead	1,983	424	3,109	779	.....	.....	6,295
Broadwater	90	75	55	.....	.....	.....	220
Cascade	1,956	.....	14,947	.....	.....	.....	16,903
Deer Lodge	22,001	2	.....	.....	.....	.....	22,003
Fergus	42,155	13	.....	.....	.....	.....	42,168
Gallatin	100	.....	.....	.....	.....	.....	100
Granite	24,282	116	207	.....	.....	.....	24,605
Jefferson	18,421	204	12,743	.....	1,459	386	33,213
Lewis and Clark	57,624	54	530	192	.....	.....	58,400
Lincoln	10	.....	.....	.....	62,009	.....	62,019
Madison	4,081	211	478	.....	.....	.....	4,770
Meagher	30	42	25	.....	.....	.....	97
Mineral	.....	940	62	.....	.....	.....	1,002
Missoula	226	8	.....	.....	.....	.....	234
Park	3,900	.....	86	.....	.....	.....	3,986
Powell	61	81	289	.....	.....	.....	431
Sanders	.....	59	.....	.....	.....	.....	59
Silver Bow	44,766	3,079,222	1,020	.....	782,081	.....	3,907,089
	[a]221,686	3,081,451	33,551	971	845,549	386	4,183,594
Value per ton in gold and silver	$14.62	$2.42	$27.31	$69.20	$5.09	$17.12	$3.82

[a] Includes 130,922 tons of gold ore, 118 tons of gold and silver ore, and 90,646 tons of silver ore.

GOLD.

The output of gold in Montana decreased from $3,104,764 in 1918 to $2,229,588 in 1919, a decrease of more than 28 per cent. Since 1915 the decrease has reached $2,774,607. Silver Bow County had the largest total output, $579,638, from deep and placer mines; Lewis and Clark County followed with $498,703; and Madison County, with $316,924. The output of the placers amounted to $291,430, against $396,232 in 1918, a decrease of more than 26 per cent. Most of the placer gold resulted from the operation of dredges in Alder Gulch, Madison County, where for several years the production has been decreasing owing to the depletion of the deposit. The output of gold from Silver Bow, Deer Lodge, and Lewis and Clark counties decreased considerably, and no gold was reported from Phillips County, formerly a considerable producer. Nearly 33 per cent of the gold, was produced at amalgamation and cyanidation mills, which yielded an average recovery of $6.59 a ton of ore and tailings treated.

Gold in bullion from deep mines came principally from Lewis and Clark, Fergus, and Madison counties. The output from these counties alone was valued at $703,660. All the important districts which produce gold were affected by the continued high cost of mining. Nearly 24 per cent of the gold was contained in concentrates of all kinds, and crude ore shipped to smelters contained more than 29 per cent of the total; nearly 60 per cent came from dry or siliceous ores, more than 15 per cent from copper ore, 13 per cent from placers, and more than 8 per cent from lead-zinc ore; but gold decreased from all these sources.

Nearly 82 per cent of the total gold in 1919 was produced from 15 properties. Four of these produced more than $250,000 each—the Shannon-Piegan-Gloster mines, near Marysville, from siliceous ores; the Anaconda Co., from copper ores; the Conrey placers in Alder Gulch, Madison County; and the Southern Cross mine, at Georgetown, from oxidized iron ores. The other mines were the zinc properties of the Anaconda Co. and the North Moccasin, Butte & Superior, Angelica, Jardine, Granite Bi-Metallic, Jib, Elm Orlu, Kendall, Mitchell-Mussigbrod, and North Butte.

Mine production of gold in Montana in 1919, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Copper-lead-zinc ore.	
Beaverhead	36.18	640.05	215.50	127.84	18.02			1,037.59
Broadwater	30.91	355.54	1.81	4.16				392.42
Cascade		107.14		622.69				729.83
Deer Lodge	6.29	14,021.47	.02					14,027.78
Fergus		10,134.13	.14					10,134.27
Gallatin		23.07						23.07
Granite	205.35	3,936.40	8.53	4.70				4,154.98
Jefferson	5.18	3,725.37	6.79	2,335.13		110.00	29.99	6,212.46
Lewis and Clark	153.49	23,837.42	2.24	59.55	72.06			24,124.76
Lincoln		6.52				676.19		682.71
Madison	12,850.24	2,168.15	10.12	302.69				15,331.20
Meagher		69.01	.03	.21				69.25
Mineral	283.86		2.52					286.38
Missoula	64.97	57.01	.31					122.29
Park	66.52	1,965.17		33.05				2,064.74
Powell	210.38	27.69	4.29	101.29				343.65
Ravalli	73.00							73.00
Sanders			5.95					5.95
Silver Bow	111.55	3,215.41	16,354.74	205.84		8,152.45		28,039.99
	14,097.92	[a] 64,289.55	16,612.99	3,797.15	90.08	8,938.64	29.99	107,856.32

[a] Includes 56,301.56 ounces from gold ore, 61.58 ounces from gold and silver ore, and 7,926.41 ounces from silver ore.

SILVER.

Silver produced by mines in Montana in 1919 decreased more than 25 per cent, but the total was greater than the output of any other State, as it was in 1918. The value of the output decreased $2,751,356. Most of the silver was obtained from copper ore and lead-zinc ore; the former yielded nearly 51 per cent of the total and the latter about 29 per cent. Nearly 84 per cent of the silver came from Silver Bow County, and this was followed by Granite, Cascade, and Jefferson counties. Cyanidation and amalgamation mills produced precipitates and bullion containing 84,941 ounces, concentra-

tion mills produced concentrates containing 9,284,128 ounces, crude ore shipped to smelters contained 3,006,765 ounces, and ore leached and old tailings which were either smelted or leached yielded 162,137 ounces.

More than 90 per cent of the silver came from 14 properties, each of which produced more than 150,000 ounces. Seven of the large mining properties produced more than 400,000 ounces each—the copper and zinc mines of the Anaconda Co. and the Butte & Superior, North Butte, Elm Orlu, Davis Daly, and Granite Bi-Metallic mines. The other large producers were the tailing dump at the Butte reduction works and the Cascade Silver, East Butte, Angelica, Tuolumne, Emma, and Snow Storm mines.

Mine production of silver in Montana in 1919, in fine ounces.

County.	Placers.	Deep mines.						Total.
		Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Copper-lead-zinc ore.	
Beaverhead	2	6,597	938	12,809	55,328	.....	.....	75,674
Broadwater	7	260	137	2,958	.....	.....	.....	3,362
Cascade	.....	85,041	.....	433,905	.....	.....	.....	518,946
Deer Lodge	.....	6,551	86	.....	.....	.....	.....	6,637
Fergus	.....	2,795	17	.....	.....	.....	.....	2,812
Gallatin	.....	16	.....	.....	.....	.....	.....	16
Granite	62	576,183	8,692	6,353	.....	.....	.....	591,290
Jefferson	1	207,866	1,934	257,287	.....	9,950	5,346	482,384
Lewis and Clark	22	103,297	125	7,696	3,007	.....	.....	114,147
Lincoln	.....	2	.....	.....	.....	162,355	.....	162,357
Madison	2,152	24,780	198	11,728	.....	.....	.....	38,858
Meagher	.....	120	10	370	.....	.....	.....	500
Mineral	8	.....	279	2,148	.....	.....	.....	2,435
Missoula	5	787	18	.....	.....	.....	.....	810
Park	6	346	.....	3,111	.....	.....	.....	3,463
Powell	27	549	1,108	3,501	.....	.....	.....	5,185
Ravalli	3	.....	.....	.....	.....	.....	.....	3
Sanders	.....	.....	1,175	.....	.....	.....	.....	1,175
Silver Bow	14	691,863	6,327,108	6,094	.....	3,506,048	.....	10,531,127
	2,309	[a] 1,707,053	6,341,825	747,960	58,335	3,678,353	5,346	12,541,181

[a] Includes 63,549 ounces from gold ore, 989 ounces from gold and silver ore, and 1,642,515 ounces from silver ore.

COPPER.

The mine production of copper in Montana in 1919 decreased 153,193,562 pounds in quantity and $48,207,668 in value. The value of the output was seriously reduced by the fall in the price of the metal, which was 18.6 cents a pound in 1919.

Silver Bow County, which includes the Butte district, contributed all the copper except 928,684 pounds. Beaverhead and Jefferson counties were the only other counties that produced more than 200,000 pounds each. Copper ore was the source of nearly all the copper, though more than 2 per cent came from lead-zinc ores. Crude ore of various kinds shipped to smelters contained 20,753,079 pounds of copper, an average content of 3.53 per cent. The sulphide copper ore of smelting grade contained 20,060,220 pounds, an average content of 5.83 per cent, and the oxidized copper ores contained 59,781 pounds, an average of 6.76 per cent. Copper precipitates produced from mine waters and the washings from old tailings

contained 5,335,048 pounds. The Washoe works,[2] near Anaconda, treated in the copper-leaching plant 184,700 tons of tailings and 61,400 tons of copper ore, from which was produced 2,500 tons of cement copper. Concentrates shipped to smelters, averaging 6.07 per cent of copper, contained 138,500,432 pounds, most of it from copper concentrates. The output of copper from the Butte or Summit Valley district decreased from 321,103,693 pounds in 1918 to 169,051,440 pounds in 1919.

Ten mines in Montana each produced more than 1,000,000 pounds of copper in 1919. The mines of the Anaconda Copper Mining Co. produced more than all others combined. Other large producers, in the order of output, were the North Butte, Davis Daly, East Butte, the Butte Reduction Works' dump, Elm Orlu, zinc mines of the Anaconda Co., tailings at Anaconda, Butte Ramsdell, and Butte-Duluth mines. Outside of the Butte district, the mines that made the best production of copper were the Angelica, near Wickes, and the Atlantis, in Beaverhead County.

Mine production of copper in Montana in 1919, in pounds.

County.	Dry or siliceous ore.	Copper ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Copper-lead-zinc ore.	Total.
Beaverhead	4,184	99,152	44,495	71,283	.....	.....	219,114
Broadwater	10	23,770	91	.....	.....	.....	23,871
Cascade	324	.....	5,981	.....	.....	.....	6,305
Deer Lodge	62,661	119	.....	.....	.....	.....	62,780
Fergus	.....	1,288	.....	.....	.....	.....	1,288
Granite	71,928	11,929	378	.....	.....	.....	84,235
Jefferson	157,349	24,444	136,725	.....	12,300	11,200	342,018
Lewis and Clark	2,888	7,288	425	15,133	.....	.....	25,734
Lincoln	.....	.....	.....	.....	38,918	.....	38,918
Madison	4,710	28,523	2,716	.....	.....	.....	35,949
Meagher	.....	12,766	180	.....	.....	.....	12,946
Mineral	.....	52,748	.....	.....	.....	.....	52,748
Missoula	.....	919	.....	.....	.....	.....	919
Park	.....	.....	251	.....	.....	.....	251
Powell	.....	6,103	.....	.....	.....	.....	6,103
Sanders	.....	15,505	.....	.....	.....	.....	15,505
Silver Bow	92,447	165,037,293	1,685	.....	3,921,179	.....	169,052,604
	[a] 396,501	165,321,847	192,927	86,416	3,972,397	11,200	169,981,288

[a] Includes 73,722 pounds from gold ore, 495 pounds from gold and silver ore, and 322,284 pounds from silver ore.

LEAD.

The mine production of lead in Montana in 1919 decreased about 7 per cent from the record production of 1918. Nearly 59 per cent of the total was derived from mines in Silver Bow County, which produced 20,311,907 pounds, against 22,746,456 pounds in 1918. The production in Lincoln, Cascade, Jefferson, and Beaverhead counties was also considerable. The largest decreases were in Silver Bow and Jefferson counties. Lead-zinc ore was the source of more than 78 per cent of the lead, and lead ore yielded nearly 20 per cent. Crude ore of all kinds shipped to the smelters contained more than 15 per cent of the total lead, or 5,211,685 pounds; concentrates, 28,671,650 pounds, or more than 83 per cent; and old tailings and slags, 554,429 pounds. Lead ore shipped to smelters, most of which

[2] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

was sulphide, contained 4,593,035 pounds of lead, an average of 11.40 per cent; and the lead concentrates contained 10,158,704 pounds, an average of 41.89 per cent. The zinc concentrates contained 4,256,168 pounds, and lead-zinc concentrates 14,233,478 pounds. Nearly 93 per cent of the lead came from eight properties, six of which produced more than 1,500,000 pounds each. In the order of output they were the zinc mines of the Anaconda Co. and the Snow Storm, Butte & Superior, Emma, Cascade, Angelica, Atlantis, and Elm Orlu mines.

Mine production of lead in Montana in 1919, in pounds.

County.	Dry or siliceous ore.	Lead ore.	Copper-lead ore.	Lead-zinc ore.	Copper-lead-zinc ore.	Total.
Beaverhead	2,172	640,218	409,122			1,051,512
Broadwater	245	19,202				19,447
Cascade	86,783	2,773,492				2,860,275
Granite	2,904	74,714				77,618
Jefferson	13,591	2,645,614		90,300	23,300	2,772,805
Lewis and Clark	23,509	160,521	71,540			255,570
Lincoln				6,728,269		6,728,269
Madison	8,679	200,935				209,614
Meagher		12,028				12,028
Mineral		22,234				22,234
Missoula	1,697					1,697
Park		58,985				58,985
Powell	1,114	54,689				55,803
Silver Bow		91,071		20,220,836		20,311,907
	[a] 140,694	6,753,703	480,662	27,039,405	23,300	34,437,764

[a] Includes 8,207 pounds from gold ore, 928 pounds from gold and silver ore, and 131,559 pounds from silver ore.

ZINC.

The mine production of recoverable zinc in Montana in 1919 decreased more than 19 per cent from that of 1918. Most of the zinc came from Silver Bow County and the remainder from Jefferson and Lincoln counties. All the zinc material was sulphide and it was all milled. With the exception of 36,600 pounds of zinc from copper-lead-zinc ore, the entire output was derived from lead-zinc ore. During 1919 much of the zinc concentrate from the Butte mines, even from the Butte & Superior and Elm Orlu, was shipped to the electrolytic zinc plant at Great Falls when the railroad rates were increased. The zinc plants[3] at Washoe and Great Falls treated during the year 284,599 tons of ore and other zinciferous material, of which 191,419 tons of ore was produced by mines of the company and 93,180 tons of ore and concentrate was purchased from other companies. The plant at Great Falls produced 48,459,727 pounds of electrolytic zinc in 1919 and 3,994,251 pounds of zinc in dross, principally from Montana ore.

In 1919 five mines produced nearly all the zinc—the Butte & Superior, Elm Orlu, Anaconda (zinc), Emma, and Snow Storm mines. These properties are all at Butte except the Snow Storm mine, which is in Lincoln County. Concentrates from the Butte & Superior mill at Butte contained 113,287,464 pounds of gross zinc, an average of 54.36 per cent.

[3] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

Mine production of recoverable zinc in Montana in 1919, in pounds.

County.	Lead-zinc ore.	Copper-lead-zinc ore.	Total.
Jefferson	374,356	36,600	410,956
Lincoln	1,058,388	.....	1,058,388
Silver Bow	167,294,479	.....	167,294,479
	168,727,223	36,600	168,763,823

MINING INDUSTRY.

The beginning of the year 1919 found the mining industry of Montana in a state of depression following the war period of abnormal metal production. The price of copper was low, and the metal market was poor, while the cost of labor and supplies was unusually high. As a result, a general curtailment of production was initiated and wages were reduced. The monthly output of 25,000,000 to 30,000,000 pounds of copper by the Butte mines was reduced to about 15,000,000 pounds. In February a strike was called at Butte, several of the larger mines were closed, and production was further decreased. Later in the year, however, the price of copper increased somewhat, and in October the output of copper was about 16,000,000 pounds. In December a strike of coal miners and another slump in the price of copper added further difficulties. In general the value of the metal output of Montana was only half of that of the year 1918. These adverse conditions affected not only the copper mines but other mines of the State, as shown especially in the decrease in the production of gold and zinc. Some companies took advantage of the lull in production to continue the work of development and improvement and to complete construction work, which was under way at several of the plants. At Philipsburg and Butte the production of manganese ore was continued, but shipments were reduced when foreign ore was received by the steel plants. At Great Falls the electrolytic zinc plant was operated, but the rate of production was reduced to about 70 per cent of that of 1918.

METALLURGIC INDUSTRY.

Forty-one milling plants of various kinds were active in Montana in 1919, though many of them were operated for only a short time. They included 10 plants using the amalgamation process, 5 using amalgamation and concentration, 9 equipped for cyanidation, 2 using amalgamation and cyanidation, 1 using table concentration, and 10 using oil-flotation equipment after table concentration. Two copper-precipitating plants that extracted copper from mine waters, 1 copper-leaching plant, and 1 electrolytic zinc-leaching plant were included in the total. Of the 110,944 tons of ore and old tailings treated at gold and silver mills, 13,142 tons was treated by amalgamation and yielded 2,521.91 ounces of gold and 758 ounces of silver, or an average recovery per ton of $3.97 in gold and 0.06 ounce of silver. The ore treated by cyanidation aggregated 91,902 tons, which, with 5,900 tons of old tailings, yielded an average recovery per ton of $6.94 in gold and 0.86 ounce of silver. The total value of the bullion recovered from ore and old tailings by both amalgamation

and cyanidation decreased $220,208. During 1919, 756 pounds of mercury was purchased for mills and dredges and 64,900 pounds of sodium cyanide was used in gold and silver mills. The consumption of cyanide was 0.55 pound per ounce of gold and silver bullion and 0.66 pound per ton of ore and tailings treated. Both the ore treated and the bullion recovered by cyanidation decreased decidedly.

Gold and silver produced at mills in Montana in 1919.

County.	Ore.	Bullion recovered from ore by—				Total value.
		Amalgamation.		Cyanidation.		
		Gold.	Silver.	Gold.	Silver.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	
Beaverhead	1,763	290.06	37	164.58	213	$9,678
Broadwater	26	233.85	66	.....	.....	4,908
Deer Lodge	5	10.17	2	.....	.....	212
Fergus	42,063	.....	.....	9,765.26	2,524	204,693
Gallatin	100	23.06	16	.....	.....	495
Granite	[a] 3,035	251.91	24	[b] 30.38	[b] 3,030	9,257
Jefferson	28	.....	.....	14.20	1	295
Lewis and Clark	[c] 52,050	993.47	502	[d] 22,247.11	[d] 71,093	560,611
Lincoln	10	6.50	2	.....	.....	136
Madison	[e] 1,862	430.37	44	[f] 603.34	[f] 7,322	29,619
Missoula	200	56.75	2	.....	.....	1,175
Park	[g] 3,900	224.77	40	.....	.....	4,691
Silver Bow	2	1.00	23	.....	.....	47
	105,044	2,521.91	758	32,824.87	84,183	825,817

[a] Also yielded 167 tons of concentrates.
[b] Includes bullion from 200 tons of old tailings.
[c] Also yielded 27 tons of concentrates.
[d] Includes bullion from 4,300 tons of old tailings.
[e] Also yielded 41 tons of concentrates.
[f] Includes bullion from 1,400 tons of old tailings.
[g] Also yielded 740 tons of concentrates.

Mills in Montana equipped for the concentration of low-grade ore treated 74 per cent of the total ore mined. The concentrates produced had an average value of $44.29 a ton. The decrease in copper, zinc, and lead-zinc concentrates was pronounced.

Mine production of metals from Montana concentrates in 1919.

By counties.

County.	Ore to concentrating mills.	Concentrates produced.						Total value of concentrates.
		Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Cascade	9,165	3,055	349.46	127,265	3,729	1,438,833	.....	$226,712
Granite	85	172	851.86	1,205	76	.....	.....	18,974
Jefferson	2,336	677	332.01	15,966	23,500	113,600	410,956	65,137
Lewis and Clark	272	100	65.18	1,794	392	71,237	.....	7,205
Lincoln	62,009	7,230	676.20	162,355	38,918	6,728,269	1,058,388	636,915
Madison	32	49	292.04	699	275	2,706	.....	7,014
Mineral	940	235	2.51	279	52,748	.....	.....	10,175
Park	.....	740	1,740.40	306	.....	.....	.....	36,320
Powell	184	37	7.38	471	.....	5,098	.....	950
Silver Bow	3,014,410	1,128,373	21,126.29	8,973,788	138,380,794	20,311,907	167,294,479	49,515,217
	3,089,433	1,140,668	25,443.33	9,284,128	138,500,432	28,671,650	168,763,823	50,524,619

Mine production of metals from Montana concentrates in 1919—Continued.

By kinds of concentrates.

Concentrates.	Concentrates produced.						Total value of concentrates.
	Quantity.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Dry or siliceous	1,993	3,071.77	21,572	24,881	.....	.....	$92,288
Copper	904,058	12,770.51	5,461,925	134,510,678	.....	.....	31,400,332
Lead	12,126	1,385.93	346,962	39,590	10,158,704	.....	963,022
Zinc	143,814	4,174.52	2,134,188	1,465,201	4,256,168	131,329,099	12,561,714
Lead-zinc	78,547	4,010.60	1,314,135	2,448,882	14,233,478	37,398,124	5,494,666
Copper-lead-zinc	130	30.00	5,346	11,200	23,300	36,600	12,597

Crude ore directly smelted averaged $27.72 a ton. The accompanying table shows that there was a decrease in the quantity and value of this ore. In 1918 the total was 478,860 tons, valued at $12,831,018.

Mine production of metals from Montana crude ore shipped to smelters in 1919.

By counties.

County.	Quantity.	Gold.	Silver.	Copper.	Lead.	Total value.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	
Beaverhead	1,759	528.61	67,188	182,505	497,083	$146,469
Broadwater	191	116.38	3,199	23,871	19,447	11,460
Cascade	7,738	380.36	391,681	2,576	1,421,442	522,361
Deer Lodge	21,998	14,011.30	6,635	62,780	.....	308,747
Fergus	105	368.99	288	1,288	.....	8,191
Granite	16,025	1,885.24	527,453	84,159	77,618	649,486
Jefferson	26,666	5,754.09	450,699	318,518	2,659,205	823,913
Lewis and Clark	1,778	665.55	40,736	25,342	184,333	73,866
Madison	1,476	1,155.20	28,641	35,674	206,908	73,559
Meagher	97	69.22	500	12,946	12,628	5,037
Mineral	62	.....	2,148	.....	22,234	3,584
Missoula	34	.59	803	919	1,697	1,172
Park	86	33.06	3,111	251	58,985	7,341
Powell	247	125.88	4,687	6,103	50,705	11,673
Sanders	59	5.96	1,175	15,505	.....	4,323
Silver Bow	215,947	6,552.15	1,477,821	19,980,642	.....	5,507,004
	294,268	31,652.58	3,006,765	20,753,079	5,211,685	8,158,186

By kinds of ore.

Dry or siliceous	100,688	24,753.63	1,543,775	395,987	137,988	$2,321,698
Copper	172,472	3,593.49	800,419	20,120,001	.....	4,713,073
Lead	20,137	3,215.39	604,236	150,675	4,593,035	1,014,670
Copper-lead	971	90.07	58,335	86,416	480,662	108,745

PRODUCTION BY COUNTIES.

GENERAL FEATURES.

The following tables give the production of each metal by counties, with its total value in 1919, the production of ore and its average value per ton by counties in 1918 and 1919, and the statistics of placer mines in 1918 and 1919. They are followed by a review of the mining industry for each county and each producing mining district.

Mine production of gold, silver, copper, lead, and zinc in Montana in 1919.

County.	Gold.					Silver.	
	Placers.		Deep mines.		Total value.	Quantity.	Value.
	Quantity.	Value.	Quantity.	Value.			
	Fine ounces.		*Fine ounces.*			*Fine ounces.*	
Beaverhead	36.18	$748	1,001.41	$20,701	$21,449	75,674	$84,755
Broadwater	30.91	639	361.51	7,473	8,112	3,362	3,765
Cascade			729.83	15,087	15,087	518,946	581,220
Deer Lodge	6.29	130	14,021.49	289,850	289,980	6,637	7,434
Fergus			10,134.27	209,494	209,494	2,812	3,149
Gallatin			23.07	477	477	16	18
Granite	205.35	4,245	3,949.63	81,646	85,891	591,290	662,245
Jefferson	5.18	107	6,207.28	128,316	128,423	482,384	540,270
Lewis and Clark	153.49	3,173	23,971.27	495,530	498,703	114,147	127,845
Lincoln			682.71	14,113	14,113	162,357	181,840
Madison	12,850.24	265,638	2,480.96	51,286	316,924	38,858	43,521
Meagher			69.25	1,431	1,431	500	560
Mineral	283.86	5,868	2.52	52	5,920	2,435	2,727
Missoula	64.97	1,343	57.32	1,185	2,528	810	907
Park	66.52	1,375	1,998.22	41,307	42,682	3,463	3,879
Powell	210.38	4,349	133.27	2,755	7,104	5,185	5,807
Ravalli	73.00	1,509			1,509	3	3
Sanders			5.95	123	123	1,175	1,316
Silver Bow	111.55	2,306	27,928.44	577,332	579,638	10,531,127	11,794,862
	14,097.92	291,430	93,758.40	1,938,158	2,229,588	12,541,181	14,046,123

County.	Copper.		Lead.		Recoverable zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Beaverhead	219,114	$40,755	1,051,512	$55,730			$202,689
Broadwater	23,871	4,440	19,447	1,031			17,348
Cascade	6,305	1,173	2,860,275	151,595			749,075
Deer Lodge	62,780	11,677					309,091
Fergus	1,288	240					212,883
Gallatin							495
Granite	84,235	15,668	77,618	4,114			767,918
Jefferson	342,018	63,615	2,772,805	146,959	410,956	$30,000	909,267
Lewis and Clark	25,734	4,787	255,570	13,545			644,880
Lincoln	38,918	7,239	6,728,269	356,598	1,058,388	77,262	637,052
Madison	35,949	6,686	209,614	11,109			378,240
Meagher	12,946	2,408	12,028	637			5,036
Mineral	52,748	9,811	22,234	1,178			19,636
Missoula	919	171	1,697	90			3,696
Park	251	47	58,985	3,126			49,734
Powell	6,103	1,135	55,803	2,958			17,004
Ravalli							1,512
Sanders	15,505	2,884					4,323
Silver Bow	169,052,604	31,443,784	20,311,907	1,076,531	167,294,479	12,212,497	57,107,312
	169,981,288	31,616,520	34,437,764	1,825,201	168,763,823	12,319,759	62,037,191

Ore sold or treated, mines producing, and average value per ton of ores in Montana in 1918 and 1919.

County.	Ore sold or treated, 1919 (short tons).		Number of deep mines producing.		Average value per ton.[a]		Average value per ton in gold and silver.[a]	
	Quantity.	Increase or decrease.	1918	1919	1918	1919	1918	1919
Beaverhead	6,295	+ 1,712	30	19	$48.95	$32.08	$22.39	$16.75
Broadwater	220	− 7,154	29	17	23.48	75.91	2.94	51.04
Cascade	16,903	+ 12,288	22	23	71.97	44.32	55.05	35.28
Deer Lodge	22,003	− 14,882	5	10	13.90	14.04	12.75	13.51
Fergus	42,168	+ 4,698	11	5	5.78	5.05	5.77	5.04
Gallatin	100	+ 100	.....	1	.....	4.95	.....	4.95
Granite	24,605	− 2,346	37	45	21.55	31.03	20.85	30.23
Jefferson	33,213	− 21,648	55	51	22.76	27.37	12.10	20.13
Lewis and Clark	58,400	− 521	42	41	13.88	10.99	12.97	10.67
Lincoln	62,019	− 3,393	2	2	12.68	10.27	2.63	3.16
Madison	4,770	− 4,681	62	62	15.11	23.10	10.28	19.37
Meagher	97	− 60	5	8	77.32	51.92	.13	20.53
Mineral	1,002	− 18,981	4	2	6.44	13.73	.15	2.76
Missoula	234	+ 57	3	3	82.33	10.03	52.38	8.91
Park	3,986	+ 356	4	3	7.52	12.13	6.67	11.33
Phillips	.....	− 97,800	2	.....	2.14	.....	2.14	.....
Powell	431	− 587	18	14	22.62	29.29	13.11	19.80
Ravalli	.....	− 156	1	.....	15.09	.....	4.77	.....
Sanders	59	− 426	6	3	34.61	73.27	12.08	24.39
Silver Bow	3,907,089	−3,486,949	69	86	15.62	14.62	2.15	3.17
	4,183,594	−3,640,373	407	395	15.47	14.76	2.49	3.82

[a] Value per ton, placer product excluded.

Number and production of producing placer mines in Montana in 1918 and 1919.

County.	1918						1919					
	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver.	Total value.	Hydraulic, dry, and sluicing.	Dredging.	Drift.	Gold.	Silver.	Total value.
					Fine ounces.						*Fine ounces.*	
Beaverhead	6	.....	.....	$4,170	52	$4,222	4	.....	.....	$748	2	$750
Broadwater	5	.....	.....	4,380	28	4,408	3	.....	.....	639	7	647
Deer Lodge	.....	.....	.....	.....	.....	.....	1	.....	.....	130	.....	130
Granite	6	.....	.....	16,903	259	17,162	4	.....	.....	4,245	62	4,314
Jefferson	2	.....	.....	530	8	538	1	.....	.....	107	1	108
Lewis and Clark	14	.....	1	5,503	79	5,582	13	.....	1	3,173	22	3,198
Lincoln	1	.....	.....	59	.....	59	.....	.....	.....	.....	.....	.....
Madison	7	1	.....	336,156	2,611	338,767	2	1	.....	265,638	2,152	268,048
Mineral	11	.....	2	10,911	18	10,929	9	.....	.....	5,868	8	5,877
Missoula	5	.....	.....	1,193	4	1,197	9	.....	.....	1,343	5	1,349
Park	1	.....	1	583	4	587	1	.....	1	1,375	6	1,382
Powell	14	.....	1	8,379	57	8,436	9	.....	1	4,349	27	4,379
Ravalli	2	.....	.....	4,453	18	4,471	1	.....	.....	1,509	3	1,512
Silver Bow	5	.....	1	3,012	28	3,040	1	.....	.....	2,306	14	2,322
	79	1	6	396,232	3,166	399,398	58	1	3	291,430	2,309	294,016

BEAVERHEAD COUNTY.

Of the ore mined in Beaverhead County 1,759 tons was of shipping grade and contained $10,927 in gold, 67,188 ounces of silver, 182,505 pounds of copper, and 497,083 pounds of lead, valued in all at $146,469, or an average of $83.27 a ton. The largest part of the county output, or 3,109 tons, was lead ore and old lead slag; 424

tons was copper ore, 779 tons was copper-lead ore, and 1,983 tons was dry or siliceous ore. Placer bullion contained $748 in gold and 2 ounces of silver, against a yield of $4,170 in gold and 52 ounces of silver in 1918.

Argenta district.—Three deep mines produced 299 tons of ore, containing $2,213 in gold, 4,278 ounces of silver, 7,886 pounds of copper, and 80,447 pounds of lead, valued in all at $12,735. The principal production was oxidized lead ore from the Tilden group.

Bannack district.—Three deep mines and one placer produced 1,949 tons of ore, $17,870 in gold, 838 ounces of silver, and 12,716 pounds of copper, valued in all at $21,173. Several lots of copper ore, containing much silver, were shipped by the New York-Montana Mines Co. The Hendricks mine, operated by the Bannack Mining & Milling Co., yielded considerable gold from ore smelted and from ore treated locally by amalgamation and cyanidation.

Beaverhead district (Grant).—A little placer gold was mined at the I. X. L. property, near Wisdom.

Big Hole district.—The New Discovery placer produced some gold through sluicing operations.

Blue Wing district.—Small lots of siliceous silver ore were shipped from the Kent and Huron claims.

Bryant district (Melrose).—Three deep mines produced 3,826 tons of ore, containing $979 in gold, 62,479 ounces of silver, 188,300 pounds of copper, and 967,370 pounds of lead, valued in all at $157,250. Several hundred tons of oxidized copper-lead ore was shipped from the Hecla group, but most of the output was lead slag from the old smelter dump. Sulphide copper ore was shipped from the Columbia and Clipper claims and one lot of lead ore from the Mountain View property.

Camp Creek district.—The Banner property, near Melrose, produced one lot of copper-lead ore.

Elkhorn district (Wise River).—The Boston-Montana Development Co. was engaged in developing the Central and Old Elkhorn properties, building a concentration mill, and completing the railroad from Divide, on the Oregon Short Line Railroad, to the town of Wise River, 38 miles southwest. Notes from printed reports [4] follow:

During the time that has elapsed since the organization of the Boston & Montana Development Co. the big double-tracked tunnel on the Wise River side of the Elkhorn district has been driven in the mountain over 4,000 feet and the veins cut 1,140 feet perpendicular from the surface. In crosscutting to the various veins and raising to the upper workings more than 10,000 feet of tunnels and upraises have been driven on the 1,140-foot level, this, with other work, making an approximate footage of tunneling and shafting on the Elkhorn properties of about 40,000 feet, or nearly 8 miles. The veins on the lower levels have been found to carry their size and values as shown in the upper workings. Indeed, in most cases the values have increased. This work has conclusively proven the existence of many million tons of ore of a grade that will be highly profitable. We now have in sight and are reasonably sure of enough ore to keep 1,000 tons per day capacity mill in operation for 10 years.

After proving the volume and values transportation became necessary. A railroad running from Divide on the Oregon Short Line (Union Pacific System) to the properties has been completed and is in operation.

A mill of the concentration flotation type, with a capacity of 750 tons per day, is being constructed and will be completed this summer. Over 35 miles of wagon roads were constructed, two sawmills erected, camp buildings for housing families, and boarding houses for miners and other laborers, accommodating a total of from 250 to 300 men, have been built.

[4] Boston & Montana Development Co. Ann. Rept. for year ending Jan. 31, 1919; statement to stockholders Apr. 27, 1920.

Waterways have been developed, town sites laid out, and a high-tension power line under construction, and, with all, a broad constructive program has been carried out during the past six years. * * *

During the past year over 3,500 feet of development work was done, principally in raising from the lower or main working tunnel to the upper Idanha tunnel, a distance of about 700 feet. A crosscut from that tunnel to the Central, Bluejay, Elkhorn, and Park veins was run, cutting the Park vein on that level at a depth of about 550 feet from the surface. One thousand feet south of the Idanha vein the Central vein was encountered, which showed considerable width and some very high-grade ore, running as high as $150 per ton in copper and silver. While the vein at this point is very irregular, the ore is high grade. Fifteen hundred feet in the same crosscut from the Idanha vein the Bluejay vein was cut, which showed a width of over 4 feet of ore, assaying $45 per ton in silver, lead, and copper, with additional width of 4 feet of good milling ore. Drifting is now in progress on this vein, which continues in its width and with apparently increasing values. * * *

The Park and Elkhorn veins were cut apparently at a point where they merged with each other and show a width of over 20 feet of good milling ore. Drifting is now in progress, and in the course of a few hundred feet no doubt these veins will separate from each other and will assume their respective courses. * * *

Polaris district.—A few lots of siliceous silver ore were shipped from the Polaris property, operated by the Silver Fissure Co., and from the Cochran property.

Utopia district (Reichle).—Sulphide copper ore was produced at the Indian Queen mine and a test lot of silver ore from the Utopia group.

Vipond district.—One lot of silver ore, containing copper, was shipped from the Gray Jockey property, near Divide.

Unorganized district.—The Jake Creek mine, 20 miles southeast of Dillon, produced one lot of silver ore.

BROADWATER COUNTY.

The greater part of the ore (191 tons) from Broadwater County was first-class ore, and the remainder was treated by amalgamation. The total output consisted of 75 tons of copper ore, 90 tons of siliceous ore, and 55 tons of lead ore. The placer bullion contained $639 in gold and 7 ounces of silver, against $4,380 in gold and 28 ounces of silver in 1918.

Backer district (Canton).—Operators of four deep mines and two placers reported the output of 33 tons of ore, $5,734 in gold, and 170 ounces of silver, valued in all at $5,925. A few tons of ore was treated by amalgamation at the Last Chance property, and a small quantity of gold ore was produced at the Humming Bird mine. Most of the gold came from the Slim Jim property, where rich gold quartz was treated in a 1-stamp mill. Small amounts of placer gold are purchased by buyers, but no regular operations are reported.

Beaver district.—A little ore, containing gold and silver, was shipped from the Peosta mine, and sulphide lead ore, containing considerable silver, was shipped from the Little Olga property. The Montana Radersburg property was developed by 50 feet of shafts and 500 feet of crosscuts.

Cedar Plains district (Radersburg).—Seven deep mines produced 87 tons of ore, containing $585 in gold, 643 ounces of silver, 4,099 pounds of copper, and 9,486 pounds of lead, valued in all at $2,570. Most of the ore was oxidized lead material from the Bonestreet claim and sulphide copper ore from the Copper King property. The remainder consisted of small test shipments from several properties.

Hellgate district.—The Eclipse-Argo mine, formerly a large producer of copper ore, was inactive in 1919, though one lot of ore mined in 1918 was received at the smelter early in 1919.

Park district (Townsend).—Three deep mines and one placer produced 29 tons of ore, $1,486 in gold, 35 ounces of silver, 655 pounds of copper, and 245 pounds of lead, valued in all at $1,660. The only notable production was a shipment of rich gold ore from the Jack Pine property.

CASCADE COUNTY.[5]

Mine production in Cascade County, Mont., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	22	4,615	$7,524	246,523	.....	1,100,085	$332,153
1919	23	16,903	15,087	518,946	6,305	2,860,275	749,075
Increase, 1919	1	12,288	7,563	272,423	6,305	1,760,190	416,922

The greater part of the ore (9,165 tons) in Cascade County was milled and reduced to 3,055 tons of lead concentrate. The remainder was first-class ore. The concentrate had an average value of $74.21 a ton and the first-class ore $67.51 a ton.

Black Eagle, near Great Falls, has developed from a smelting to a manufacturing center. Converter copper from the plant at Anaconda is refined and made into copper wire and bars. Zinc ore from Butte is milled at Anaconda and leached at Black Eagle. Zinc from the electrolytic plant is distributed to consumers. The zinc plant was idle half the year, and the ferromanganese plant was not operated. Results are given by the Anaconda Copper Mining Co. under the Butte district, Silver Bow County.

Montana and Barker district (Neihart).—Twenty-one deep mines produced 16,893 tons of ore, containing $15,086 in gold, 518,704 ounces of silver, 6,305 pounds of copper, and 2,857,816 pounds of lead, valued in all at $748,672. The greater part of the ore, 9,165 tons, was concentrated to make 3,055 tons of concentrates and 7,728 tons was shipped directly to smelters. In 1918 twenty deep mines in the district produced 4,533 tons of ore, valued at $325,491. The ore of this district, near Neihart, is low-grade sulphide lead ore, containing considerable silver. The largest operations were carried on at the Broadwater and Moulton mines by the Cascade Silver Mines & Mills. A large part of the ore was shipped without treatment, and at the same time ore was treated in the concentration mill, which was being remodeled and improved late in the year. The Broadwater tunnel was cleaned out for 2,000 feet, and in October the mill was treating 150 tons a day by concentration and flotation. The high price of silver created much activity in the district both in 1918 and 1919, and

[5] Weed, W. H., Geology of the Little Bell Mountains, Mont.: U. S. Geol. Survey Ann. Rept., pt. 3, pp. 257–581, 1900.
Weed, W. H., and Pirsson, L. V., Geology and Mineral Resources of the Judith Mountains of Montana: U. S. Geol. Survey, Eighteenth Ann. Rept., pt. 3, pp. 445–616, 1898.

many of the old properties were rejuvenated. The Benton Group Mining Co. shipped more than 1,500 tons of ore, and the Galt, Blackbird, Wright & Edwards, and Silver Belt mines shipped several hundred tons each. Ore was also shipped from the Ripple, Alice & Hartley, Barker Mines, Big Seven, Champion, Cornucopia, Dr. Kalloch, Fairplay, Florence, London, and Broken Hills properties.

Running Wolf Creek district.—Small lots of sulphide lead ore were shipped from the Romer mine and the Silver claim, near Stanford.

DEER LODGE COUNTY.

Mine production in Deer Lodge County, Mont., 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	
1918	5	36,885	$453,083	17,215	171,332	$512,617
1919	[a] 11	22,003	[b] 289,980	6,637	62,780	309,091
Increase or decrease, 1919	+6	−14,882	−163,103	−10,578	−108,552	−203,526

[a] One placer.
[b] Includes small placer production.

The output of Deer Lodge County, principally iron ore containing much gold, was shipped to the Washoe smelter, where it was used as a flux.

Most of the ore from the Butte district is milled, leached, or smelted at Anaconda.[6] No changes were made in the main features of the plant, but decided progress was recorded in the treatment of fumes by the Cottrell process. The new stack and fume treaters were in operation in August, though the reverberatories and converters were not operated at full capacity. The results are given in the notes on the Butte district.

Dry Gulch district.—A small quantity of placer gold was mined in Dry Gulch, 10 miles north of Anaconda.

Georgetown district (Southern Cross).—Five deep mines produced 21,935 tons of ore, containing $289,847 in gold, 5,167 ounces of silver, and 62,393 pounds of copper, valued in all at $307,239. Practically all the ore was shipped directly to the smelters, and most of it was gold-bearing iron ore. The Southern Cross mine, operated by the Anaconda Copper Mining Co., produced the greater part of the ore, and a large quantity of ore was shipped from the Holdfast and Oro Fino properties. A small output of gold resulted from a clean-up of the old Cable property.

Silver Lake district.—Several lots of siliceous silver ore were shipped from the Lucky Boy and other properties, about 13 miles west of Anaconda.

[6] Weed, W. H., Mines Handbook, vol. 14, pp. 868–970, 1920.

FERGUS COUNTY.

Mine production in Fergus County, Mont., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	11	37,470	$210,426	5,725	402	5,333	$216,629
1919	5	42,168	209,494	2,812	1,288	.....	212,883
Increase or decrease, 1919	−6	+4,698	−932	−2,913	+886	−5,333	−3,746

All the ore produced in Fergus County with the exception of 13 tons, was siliceous, and most of it was treated by cyanidation. The ore milled had an average value of $4.87 a ton, and the ore shipped (105 tons) of $78.01 a ton. The mines that produce low-grade gold ore continue to suffer from increased expenses.

North Moccasin district (Kendall).—Two deep mines produced 42,013 tons of ore containing $201,513 in gold and 2,504 ounces of silver, valued together at $204,317. All the ore was treated by cyanidation. The North Moccasin mine and mill, owned by the Barnes King Development Co., were active throughout the year, and a large production of gold and silver bullion resulted from the operation of the cyanide leaching plant. No important changes were made at the property and at the end of the year it was reported that the mine was nearly worked out. The company's report [7] gives the following notes:

The North Moccasin mine production for the year 1919 exceeded that of 1918 by 4,465 tons, but the value decreased by $1.63 per ton.

Comparison of production by years.

Year.	Quantity (short tons).	Value per ton.	Bullion sales.
1913	49,726	$8.89	$400,854.43
1914	51,471	8.44	424,410.96
1915	47,038	9.80	418,568.76
1916	33,715	8.65	253,788.29
1917	26,790	8.53	227,925.13
1918	21,378	8.19	178,229.98
1919	25,843	6.56	178,191.33

The greater part of the tonnage mined came from the ground around the Santiago shaft above the 300 level, but from which little more can be expected. Small pillars all over the mine were cleaned up and low-grade values around the edges followed with a consequent high cost for mining and reduction in grade of mill rock.

The only new stope found was one on the line between the Agnes and Possible claims, just below the 600 level, which was opened on the first of November and gave very considerable promise. This is a rather flat ore body and has been developed to a width of 40 feet by 170 feet long with possibility of extension to the south on dip, where exploration work is now being pushed.

With developments as they are at present future tonnage must come from this stope. Properly speaking, there are no ore reserves because stoping is keeping up with development.

[7] Barnes King Development Co. Ann. Rept. for year ending Dec. 31, 1919.

Development work consisted of 2,651 feet of drifts and crosscuts, 596 feet of raises, and 337 feet of winzes.

The milling of ore consumed 0.38 pound of sodium cyanide per ton of ore, 0.39 pound of zinc shavings, and 3.8 pounds of lime.

The Kendall mine was leased under similar terms as for the preceding three years, work being confined to the ground above the 100 level.

While most of the mill rock came from the open cut, there was 63 feet of shaft sunk and timbered and 771 feet of drifts and raises were completed in underground work. The total production was 16,170 tons mined and milled, averaging $1.96 per ton, on which $1,442.37 was paid * * * as royalty and the additional sum of $1,744.60 for power used.

The Kendall mine was operated during the entire year by the Kendall Leasing Co. A large quantity of ore was treated by cyanidation, but the grade was low.

Warm Springs district (Giltedge).—Three deep mines produced 155 tons of ore, containing $7,981 in gold, 308 ounces of silver, and 1,288 pounds of copper, valued in all at $8,566. In 1918 eight mines produced ore valued at $20,585. The Spotted Horse mine, near Maiden, produced some unusually rich gold ore, which was smelted. One lot of sulphide copper ore was shipped from the Sutter claims, on West Armels Creek. Development work at the Judith Mountain Gold Mining Co. consisted of 250 feet of drifting.

GALLATIN COUNTY.

Ore from the Anderson mine, in the Madison Range, between Manhattan and Spanish, yielded some gold and silver by amalgamation. The Apex Developing Co., near Eldridge, did 500 feet of tunneling.

GRANITE COUNTY.

Mine production in Granite County, Mont., in 1918 and 1919.

Year.	Number of producers.		Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Total value.
	Placers.	Deep mines.	*Short tons.*		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	6	37	26,951	$108,307	470,697	70,260	22,037	$597,923
1919	4	45	24,605	85,891	591,290	84,235	77,618	767,918
Increase or decrease, 1919	−2	+8	−2,346	−22,416	+120,593	+13,975	+55,581	+169,995

[a] Includes placer production.

The crude ore shipped (16,025 tons) from Granite County contained gold, silver, copper, and lead and had an average value of $40.53 a ton. In gold and silver mills 3,035 tons of ore and 200 tons of old tailings were treated, principally by amalgamation, and yielded bullion containing $5,836 in gold and 3,054 ounces of silver, also some concentrate. The remainder, except 85 tons treated in concentration mills, consisted of old tailings, which were smelted. Four placer operators reported the production of $4,245 in gold and 62 ounces of silver, against $16,903 in gold and 259 ounces of silver from six placers in 1918. The mines near Philipsburg also produced a large output of manganese ore, which was shipped to steel plants in the Eastern States.

Alps district (*Bonita*).—A small quantity of gold ore from the Rainy Day mine was treated by amalgamation.

Black Pine district.—A large quantity of copper ore, containing considerable silver, was shipped from the Black Pine property, 16 miles northwest of Philipsburg, and placer gold was marketed from the Homestake claim, on Willow Creek.

Dunkleberg district.[8]—The Forest Rose mine of the Dunkleberg Mining Co. produced several cars of sulphide lead ore.

First Chance district (*Garnet*).[8]—Ten deep mines and one placer produced 3,476 tons of ore, $37,412 in gold, 3,961 ounces of silver, and 7,732 pounds of copper, valued in all at $43,286. Most of the ore, or 2,885 tons, was treated by amalgamation, and nearly all the remainder, or 506 tons, was first-class crude ore. A large part of the ore was mined by the Mitchell-Mussigbrod Mining Co. and treated in a 10-stamp mill equipped for amalgamation and concentration. Flotation equipment was added in 1919. The Nancy Hanks mine, which is opened by a 500-foot inclined shaft and 4,000 feet of drifts and crosscuts, produced several cars of ore, containing principally gold. Gold ore was also milled at the Grant-Hartford mine, which is under lease. Other mines from which ore was shipped were the Mountain Group, Dewey Dump, and Red Rock properties.

Flint Creek district (*Philipsburg*).[9]—Twenty-five deep mines produced 19,595 tons of ore, containing $41,894 in gold, 546,347 ounces of silver, 40,803 pounds of copper, and 18,137 pounds of lead, valued in all at $662,354. Most of the district output was silver-bearing crude ore and old tailing shipped to smelters. The high price of silver made a decided change in the output of the district, and many of the old properties were operated by lessees. The largest output was that of the Granite-Bimetallic mine, which consisted of crude ore and old tailing. This property has 26 miles of drifts and 15 miles of crosscuts. Ore containing much silver was also shipped by the Philipsburg Mining Co., as well as manganese ore to eastern steel plants. Other productive properties were the Comanche Extension, Eagle, John Mitchell, Headlight, Moonlight, Hobo, Imperial, Young America, Pocahontas, Scratchall, Two Percent, and Patten mines.

Henderson district.—At the Coyote group, belonging to the Windfall Mining Co., old tailing, containing gold and silver, was cyanided.

Rock Creek district.—The Basin Mining Co. operated the Basin placer, near Philipsburg, and produced some gold by hydraulic mining.

South Boulder district (*Maxville*).—Six deep mines produced 167 tons of ore, containing $98 in gold, 5,086 ounces of silver, and 3,265 pounds of copper, valued in all at $6,402. The output, most of which was siliceous silver ore, was shipped without treatment. The Mount Powell, Silver Crest, Ottman, Derosia, Scherr, and Holland properties also produced several cars of first-class ore.

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[8] Pardee, J. T., Ore deposits of the northwestern part of the Garnet Range, Mont.: U. S. Geol. Survey Bull. 660, pp. 159–239, 1918; The Dunkleberg mining district, Granite County, Mont.: Idem., pp. 241–247.

[9] Emmons, W. H., and Calkins, F. C., Geology and ore deposits of the Philipsburg quadrangle: U. S. Geol. Survey Prof. Paper 78, 1913.

JEFFERSON COUNTY.[10]

Mine production in Jefferson County, Mont., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ozs.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	[b] 57	54,861	$126,448	537,777	345,545	3,881,482	2,463,673	$1,249,354
1919	[b] 52	33,213	128,423	482,384	342,018	2,772,805	410,956	909,267
Increase or decrease, 1919	−5	−21,648	+1,975	−55,393	−3,527	−1,108,677	−2,052,717	−340,087

[a] Includes placer production.
[b] Includes two placers in 1918 and one in 1919.

The output in Jefferson County consisted of 26,666 tons of first-class ore, 4,183 tons of tailing shipped, and 2,336 tons of ore concentrated. The concentrates, 677 tons, had a total value of $65,137, or an average of $96.21 a ton. The shipping ore contained gold, silver, copper, and lead valued at $823,913, or an average of $30.90 a ton. The ore and tailing were classified as 12,743 tons of lead material, 18,421 tons of siliceous ore and tailing, 1,459 tons of lead-zinc ore, 386 tons of copper-lead-zinc ore, and 204 tons of copper ore. One placer operator reported a small production. The price of silver has stimulated mining at several of the old producing mines of Jefferson County, which are within easy reach of the smelters at East Helena, Butte, and Anaconda, Mont.

Amazon district.—Four deep mines produced 99 tons of ore, containing $174 in gold, 1,461 ounces of silver, 288 pounds of copper, and 24,994 pounds of lead, valued in all at $3,189. Sulphide lead ore and siliceous silver ore were shipped from the Amazon, Australian, Evening Star, and Mono properties. At the Boulder-Anaconda property the old workings were cleaned out and 1,000 feet of steel track laid.

Boulder district.—The Baltimore Copper Co. operated the Baltimore group, 5 miles northwest of Boulder. Oxidized lead ore and siliceous silver ore were shipped to a lead smelting plant, and some ore, containing copper, lead, and zinc, was shipped to Anaconda for concentration.

Cataract district (Basin).—Fifteen deep mines and one placer produced 11,748 tons of ore, $68,067 in gold, 143,539 ounces of silver, 175,661 pounds of copper, 832,982 pounds of lead, and 374,356 pounds of recoverable zinc, valued in all at $332,980. Most of the ore, or 9,798 tons, contained gold, silver, copper, and lead and was shipped directly to smelters, and 1,950, tons was reduced to 547 tons of concentrates. The largest output of the district consisted of first-class lead ore and siliceous silver ore from the Comet mine, operated by the Montana Consolidated Mines Co. Milling ore, which contained lead and zinc, was also produced. A large quantity of ore, containing silver and gold with some copper, was shipped from the Bullion mine, and from the Crystal property, an old producer, much silver ore and lead ore were shipped. Ore was also shipped from the Silver

[10] Knopf, Adolph, Ore deposits of the Helena region, Mont.: U. S. Geol. Survey Bull. 527, 1913.

Hill, Gray Eagle, West Rumley, and Jib properties. The Jib Mining Co. operated the Katie and Hope mines, which are developed by vertical and inclined shafts and 3,500 feet of drifts and raises. Some exceptionally rich gold ore was marketed during the year and ore was also treated by concentration.

Colorado district (Wickes).—Eight deep mines produced 11,218 tons of ore, containing $45,499 in gold, 210,826 ounces of silver, 138,665 pounds of copper, and 1,751,879 pounds of lead, valued in all at $400,266. The entire output was first-class shipping ore. In 1918 the mines of this district produced 14,145 tons of ore, valued at $474,459. As in recent years, the largest production was that of the Mount Washington mine, operated by the Angelica Mining & Development Co., the principal product of which was sulphide lead ore, containing considerable gold and silver. A large quantity of siliceous silver ore was also shipped. The mine is opened by a tunnel 4,000 feet long and is said to have 5 feet of galena at a depth of 900 feet. Ore containing gold, silver, and copper was shipped from the Wickes dump. Other shippers in the Colorado district were the Blue Stone, Glenbeg, Dailey group, Blue Bird, and Big Chief mines. The tunnel at the Mountain View mine was driven 200 feet in 1919.

Elkhorn district.—Six deep mines produced 7,723 tons of ore and old tailing, containing $10,000 in gold, 38,567 ounces of silver, 4,237 pounds of copper, and 20,776 pounds of lead, valued in all at $55,084. Most of the output, or 4,183 tons, was old tailing, containing silver and gold, and nearly all the remainder, or 3,512 tons, was crude ore shipped to smelters. The Holter mine of the Elkhorn Silver Mining Co. produced a large quantity of silver ore, some lead ore, and the old tailing mentioned above. An iron fluxing ore, containing gold and silver, was shipped from the Golden Curry property. Other producers were the Passover, Saracen, C. & D., and Hagan mines. The Pittsmont Copper Co. owns the Swissmont property, near Elkhorn, on which a large body of low-grade gold ore has been developed. In 1916 a cyanide mill was built, but later the cost of labor and material increased to such an extent that the mill was not operated.

Elk Park district.—A few lots of silver ore were shipped from the Eureka and Butte Elk Park Extension properties, near Elk Park station on the Great Northern Railway. The Elk Park Mining Co. did some development work in shaft and crosscuts.

Homestake district.—Five deep mines produced 43 tons of ore, containing gold, silver, and copper, valued in all at $1,321. The largest production was silver ore from the Montana property.

Lump Gulch district (Clancey).—Seven deep mines produced 770 tons of ore, containing $334 in gold, 61,905 ounces of silver, 190 pounds of copper, and 9,248 pounds of lead, valued in all at $70,193. All the output was first-class silver ore shipped to smelters. The Free Coinage mine was operated by the Amalgamated Silver Mines Co., and a quantity of silver ore was shipped while the property was being developed. The mine is opened by a 250-foot shaft and 3,000 feet of drifts, and work during 1919 consisted of 1,000 feet of drifting. The Legal Tender mine also produced first-class silver ore, and small lots were shipped from the Nipsic and Liverpool properties. Considerable development work was done at the Muskegon and Little Nell properties.

Whitehall district.—The Milburn mine, near Whitehall, produced several lots of oxidized lead ore and gold ore. One car of lead ore was shipped from the Carbonate mine.

LEWIS AND CLARK COUNTY.

Mine production in Lewis and Clark County, Mont., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
Placers:							
1918	15	.....	$5,503	79	.....	.....	$5,582
1919	14	.....	3,173	22	.....	.....	3,198
Deep mines:							
1918	42	58,921	628,994	135,308	7,025	726,520	817,620
1919	41	58,400	495,530	114,125	25,734	255,570	641,682
Increase or decrease, 1919	−2	−521	−135,794	−21,240	+18,709	−470,950	−178,322

In Lewis and Clark County gold and silver mills treated 52,050 tons of ore and 4,300 tons of old tailing, principally by cyanidation, and produced bullion containing $480,425 in gold and 71,595 ounces of silver, or an average value of $9.95 a ton. Only 272 tons were treated in concentration mills, but crude shipping ore aggregated 1,778 tons and contained $13,758 in gold, 40,736 ounces of silver, 25,342 pounds of copper, and 184,333 pounds of lead, valued in all at $73,866, or an average of $41.54 a ton. Of the total quantity, 57,624 tons was siliceous ore, 54 tons copper ore, 530 tons lead ore, and 192 tons copper-lead ore. The placer output of 14 producers amounted to $3,173 in gold and 22 ounces of silver, against $5,503 in gold and 79 ounces of silver in 1918. The only active lead-smelting plant in Montana is at East Helena. Custom lead ore and concentrate from Idaho, Montana, and British Columbia were smelted during 1919, and the lead bullion was shipped at the rate of about 2,000 tons a month to Omaha, Nebr., for refining. The maximum capacity of the plant is 900 tons of charge a day.

Bald Butte district (*Marysville*).—At the Bald Butte property, 6 miles from Marysville, gold ore was treated by amalgamation and concentration in a 40-stamp mill.

Big Blackfoot district.—A few tons of gold ore was produced at the Lockey property, near Stemple.

Greenhorn district (*Austin*).—Four deep mines and one placer produced 187 tons of ore, $168 in gold, 5,664 ounces of silver, 3,888 pounds of copper, and 3,552 pounds of lead, valued in all at $7,423. Most of the output was siliceous silver ore from the Stem Winder mine, operated by the Solar Mining Co., and small lots of ore were shipped from the Blue Bell, Allard, and Far West claims.

Heddleston district.—Several cars of oxidized copper-lead ore, containing considerable gold and silver, were shipped from the Anaconda mine.

Helena district.—One deep mine and five placers produced $1,528 in gold and 11 ounces of silver. Part of the gold resulted from drifting and sluicing on patented ground owned by the city of Helena in Last Chance Gulch.

Lincoln district.—Two deep mines and one placer produced 273 tons of ore, $341 in gold, 1,662 ounces of silver, 229 pounds of copper, and 71,237 pounds of lead, valued in all at $6,020. A small placer production was won by sluicing at the Harvey claim, near Lincoln, and several cars of lead concentrate resulted from milling operations at the Mike Horse mine, operated by the Sterling Mining & Milling Co., near Flesher, Mont.

Mitchell district.—Development was continued at the Economy property and a 150-ton concentration mill was erected.

Ottawa district (Marysville).—Ten deep mines produced 53,761 tons of ore and old tailing, containing $466,680 in gold, 77,436 ounces of silver, 4,801 pounds of copper, and 82,657 pounds of lead, valued in all at $558,682. Practically all the ore and old tailing was treated by cyanidation and 329 tons of ore was shipped directly to smelters. The largest producer of the district and one of the chief gold producers of Montana was the Shannon-Piegan-Gloster group, operated by the Barnes King Development Co. This property is developed by 6,446 feet of drifts, crosscuts, raises, and winzes. The printed report [11] of the company gives the following information:

Development work in the Piegan-Gloster mine was continued at the west end of the Gloster in the slate country rock and at the east end in granite. The latter work produced a small tonnage of ore, found close to the old stopes, but on the whole was discouraging, and the ground east of the Gloster shaft was practically abandoned. Better results were had at the west end of the Gloster 500 level, where at a point 1,400 feet west of the shaft a winze was sunk 100 feet in good grade ore and a level driven from the bottom, 611 feet in length, opening 200 feet of stoping ground, but with lower values than were found in the winze.

Production to date:

Year.	Quantity (short tons).	Value per ton.	Bullion sales.
1915	14,956	$7.22	$85,533.39
1916	22,144	6.15	133,587.90
1917	20,525	10.43	210,310.92
1918	15,338	9.21	141,326.60
1919	11,917	6.27	78,425.53

The gold was valued at $49,611 and the silver at $29,063. * * *

Development consisted of 2,453 feet of drifts and crosscuts, 414 feet of raises, and 132 feet of winzes. * * *

Ore sent to the Gloster mill from the Shannon mine averaged slightly better than 100 tons per day, the year 1919 thus being the record year for mine in point of tonnage.

The work of the period under review was largely confined to the opening of the footwall vein lying west of the Shannon vein, from the 650 level to the 400 level and above. So far this shoot has not been found on the 300 level or on the tunnel level and it would appear that the shoot pinches out not far above the 400 level. On the 650 level the payable length of the shoot was found to be approximately 100 feet—one-fourth the length above—so that there is little inducement to explore below the bottom level, which is the 650, with the present outlook.

The 400 level was driven westerly 968 feet to a point 1,470 feet from the shaft, but no values were found beyond the footwall ore shoot. This shoot is well within the west end line of the Sanford. In this extension of the 400 level to the west a crushed and faulted area was found, entirely unfavorable for ore shoots.

Final letters patent were received for the Lily, Eric, Reindeer, Rosebud, Shannon, Ox Bow, Barking, Diurnal, Grouse, Mary, Summer Coon, Janettee, and Bell claims, totaling 202 acres. These claims, together with the Sanford claim, the only one patented heretofore, comprise the Shannon group. * * *

[11] Barnes King Development Co. Ann. Rept. for year ending Dec. 31, 1919.

The production for the last four years is as follows:

Year.	Quantity (short tons).	Value per ton.	Bullion sales.
1916	13,392	$13.94	$180,485.69
1917	32,359	15.17	492,683.74
1918	26,048	13.02	349,138.35
1919	36,740	10.75	424,709.82

Development consisted of 2,638 feet of drifting and crosscutting and 809 feet of raising. * * *

Ore milled from both mines—48,626 tons—had an average value of $10.21 a ton. The saving was 96.4 per cent of the gold and silver content. Milling cost $1.74 a ton, labor 58 cents, material and supplies 89 cents, electric power 19 cents, and maintenance 8 cents. * * *

Two properties were under option during the year, the Mount Pleasant near the Shannon mine and the Silver Bullion group in the Judith mountains. On the former 499 feet of development was completed, making a total of 1,036 feet since the ground was optioned in 1918. This work was unsuccessful in finding an ore shoot, which was expected from the work done many years ago, and the property was turned back to the owners early in the year. * * *

Operating conditions have continued unsatisfactory, prices for supplies have steadily increased in many instances, and the labor situation has become worse rather than better.

Dividends paid in 1919, partly from the surplus of 1918, amounted to $120,000.

Some silver ore was shipped from the Drumlummon mine, and several thousand tons of old tailing was treated locally by cyanidation. A 5-stamp mill was operated for a short time at the Lucky Girl mine, and gold bullion was recovered by amalgamation. Several cars of gold ore were shipped from the Cruse & Bald Mountain property, owned by the Thomas Cruse Mining & Development Co. Other producers were the Shokope, Nile, Uncle Ben, and Carbonate mines.

Scratch Gravel district.—Silver ore was shipped from the Silver Coin property, and a small lot of lead ore from the Morning Star mine. The district formerly produced considerable gold from the Franklin and the Scratch Gravel mines.

Seven Mile district.—The Saginaw property produced a small quantity of silver ore of good grade.

Stemple district.—Three deep mines and one placer produced 461 tons of ore, $5,536 in gold, 372 ounces of silver, and 163 pounds of copper, valued in all at $5,983. Most of the gold was recovered from ore milled at the Rover and Bell Boy mines. The Bell Boy property was operated by the Intermountain Engineering & Development Co. and produced gold bullion and concentrates.

Unionville district.—At the Whitlatch mine 5 stamps were operated on gold ore, and a small quantity of bullion was shipped to the assay office.

Vaughn district (Rimini).—Ten deep mines and one placer produced 2,408 tons of ore, $9,344 in gold, 21,415 ounces of silver, 2,375 pounds of copper, and 58,338 pounds of lead, valued in all at $36,863. Of the ore mined, 1,008 tons was shipped directly to smelters and 1,400 tons was treated in gold and silver mills. The material milled was low-grade gold ore from the Porphyry Dike property. Most of the shipping ore was siliceous silver ore from the Josephine and Peerless Jennie mines. The Bullion, Valley Forge, Sixty Ninth, Lee Mountain, Mary Alois, and Bassett properties also produced shipping ore.

Wolf Creek district.—One lot of silver ore was produced from the Liberty lode and sulphide copper ore from the Copper Chief mine.

LINCOLN COUNTY.

Most of the output in Lincoln County was lead-zinc ore, which was concentrated and separated into a lead concentrate and a lead-zinc concentrate. A small part, 10 tons, was treated by amalgamation. No placer production was reported in 1919.

Libby district.—A small quantity of gold bullion resulted from former operations at the Rose Consolidated property, near Libby. The property was idle in 1919 except for the annual assessment work. The Lukens Hazel mine was being developed, and a mill and a power plant are planned.

Troy or Callahan Creek district.—The only productive mine in the district was the Banner & Bangle property, operated by the Snow Storm Mines Consolidated. The concentration mill, which has a capacity of 350 tons a day, was active 196 days, treating lead-zinc ore. Lead concentrate was shipped to Midvale, Utah, and zinc concentrate to the electrolytic zinc plant at Black Eagle, near Great Falls, Mont. The mine was operated during the entire year and development work consisted of 1,279 feet of cross-cutting and 253 feet of drifting. No printed report for 1919 was published, which is one of the unfortunate consequences of small profits and general economy. The quantity of ore milled was about the same as in 1918, but the quantity of lead concentrate shipped was larger. The chapter[12] for 1918 gave the contents of mill feed and of concentrates shipped.

MADISON COUNTY.[13]

Mine production in Madison County, Mont., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.	Silver.	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
Placers:								
1918	8	.....	$336,156	2,611	.....	.....	.....	$338,767
1919	3	.....	265,638	2,152	.....	.....	.....	268,048
Deep mines:								
1918	62	9,451	56,928	40,235	54,904	437,205	11,114	142,777
1919	62	4,770	51,286	36,706	35,949	209,614	.....	110,192
Decrease, 1919	5	4,681	76,160	3,988	18,955	227,591	11,114	103,304

The larger part of the ore (1,862 tons), with 1,400 tons of old tailing from Madison County in 1919, was treated at gold and silver mills and yielded bullion containing $21,369 in gold and 7,366 ounces of silver, or an average value of $9.08 a ton. Ore shipped amounted to 1,476 tons, valued at $73,559. Of the ore mined 4,081 tons was classified as dry or siliceous ore, 211 tons as copper ore, and 478 tons as lead ore. Placer bullion decreased as shown in the accompanying table.

[12] U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 289, 1920.

[13] Pardee, J. T., Some manganese deposits in Madison County, Mont.: U. S. Geol. Survey Bull. 660, pp. 131-143, 1919.

Alder Gulch district (*Virginia City*).—Four deep mines and two placers in the Alder Gulch district produced 100 tons of ore, $267,885 in gold, and 4,710 ounces of silver, valued in all at $273,160. All the ore was shipped to smelters. The placer output contained gold valued at $265,621 and 2,152 ounces of silver, largely the result of dredge operations. Siliceous ore containing gold and silver was shipped from the Dewdrop, Governor Hayes, U. S. Grant, and Metallic mines. The Conrey Placer Mining Co., at Ruby, handled 4,282,349 cubic yards of gravel by dredges. The deposit, however, is being depleted and production was considerably less than in past years.

Havana district.—One car of silver ore was shipped from the Havana mine.

Lower Hot Springs district (*Norris*).—Several small test lots of ore were shipped from the Birdie, Morning Star, and Red Bluff properties, near Norris.

McCarthy district.—One car of oxidized lead ore was shipped from the Polly Jane property, and a test lot of gold ore from the Hidden Treasure group.

Mineral Hill district (*Pony*).—One lot of gold ore was shipped from the White Pine mine. In 1918 the district produced 1,069 tons of ore, valued at $8,333.

Norwegian district (*Renova*).—The Mountain View property, west of Norris, produced a small quantity of gold ore, which was shipped for smelting.

Rabbit district (*Rochester*).—The output of the Rabbit district consisted of 183 tons of ore, containing $1,904 in gold, 2,067 ounces of silver, 1,338 pounds of copper, and 43,354 pounds of lead, valued in all at $6,766. Most of the output, which consisted of gold ore and sulphide lead ore, was shipped from the Emma property.

Ramshorn district (*Laurin*).—The output of three deep mines and one placer was 198 tons of ore, $211 in gold, 542 ounces of silver, and 23,032 pounds of copper, valued in all at $5,102. The ore was of shipping grade and consisted of copper ore from the Dictator and Copper Mountain mines and a small lot of silver ore from the Castle Blue property.

Sheridan district.—Nine deep mines produced 1,267 tons of ore, containing $10,614 in gold, 8,913 ounces of silver, 2,281 pounds of copper, and 37,015 pounds of lead, valued in all at $22,983. Most of the ore, 983 tons, was treated in gold and silver mills, and the remainder was shipped to smelting plants. The largest part of the output was ore from the Tamarack property treated by amalgamation. The material is crushed with a Eureka crusher and ground in a Duco ball mill. The stamps were removed from the milling plant of the Lake Shore & Gladstone property, a Hardinge mill was installed, and precipitates from the cyanide plant were shipped East. Several lots of silver ore were shipped from the Silver Bar property, and some lead ore from the Buckeye mine, operated by the Sheridan Mining Co. Small lots were also shipped from the Silver King, Sunnyside, and Deutschland properties.

Silver Star district.—Seven deep mines produced 157 tons of ore, containing $2,620 in gold, 3,176 ounces of silver, 3,219 pounds of copper, and 5,779 pounds of lead, valued in all at $7,082. With the exception of 4 tons of milling ore, all the ore was of shipping grade.

Most of the product was siliceous ore, containing gold and silver, and a large part of it was mined at the Cannon Ball, Edgerton, Greene-Campbell, Wheal Clifford, and Ballaclava properties.

Summit district (*Virginia City*).—Ten deep mines produced 1,622 tons of ore and old tailing, containing $5,850 in gold, 9,933 ounces of silver, 697 pounds of copper, and 342 pounds of lead, valued in all at $17,123. The output consisted of 137 tons of ore smelted and 1,400 tons of old tailing and 85 tons of crude ore treated in gold and silver mills. The Easton-Pacific mine, formerly a large producer, was idle during the year, but old tailing was treated in the cyanide plant. The Winnetka, Wilson, East Mapleton, and Silver Bell properties produced small lots of smelting ore.

Tidal Wave district (*Twin Bridges*).—Ten deep mines produced 293 tons of ore, containing $9,481 in gold, 5,521 ounces of silver, 4,351 pounds of copper, and 98,292 pounds of lead, valued in all at $21,682. With the exception of 20 tons treated by amalgamation the output was first-class ore shipped to smelting plants. Lead ore was shipped from the Elenora, Sunflower, Tidal Wave, Van Meter lode, and Texas properties. Ore containing gold and silver was shipped from the Jonquil, Roulette, and Keystone mines. In 1918 the output of the Tidal Wave district was valued at $43,350.

Upper Hot Springs district (*Norris*).—Six deep mines in the Upper Hot Springs district produced 79 tons of ore, containing $2,023 in gold, 1,255 ounces of silver, and a small quantity of copper and lead, which had a total value of $3,499. Small lots of ore were shipped from the Bull Moose, Thad Stevens, and Galena properties, the last operated by the Montana Mines & Metals Co. The Revenue Mines (Inc.) equipped the mine with hoist and compressor, and did 300 feet of shaft sinking.

Washington or Meadow Creek district.—Milling operations were carried on at the Missouri and Lehigh properties, near Norris. Shipments of gold bullion and concentrate resulted from the operations of a 50-ton plant at the Missouri mine, and ore was treated by amalgamation and concentration at the Lehigh property.

MEAGHER COUNTY.

All the output from Meagher County was ore of shipping grade. No placers were active.

Castle Mountain district (*Lennep*).—Five deep mines produced 41 tons of ore, containing gold, silver, copper, and lead, valued at $1,706. One car of oxidized lead ore was shipped from the Snowdrift property and one of copper ore from the Vandor mine.

Copperopolis district.—The Biesel claim, on Copper Creek, 7 miles west of Delpine, produced one test lot of copper ore.

Musselshell district.—Some oxidized copper ore was shipped from the Copper Duke property, the result of work in the old drifts.

MINERAL COUNTY.

The output from Mineral County, which decreased decidedly, consisted almost entirely of copper ore, 940 tons, which was milled and yielded 235 tons of copper concentrate. The crude ore shipped aggregated 62 tons and was valued at $3,584, an average of $57.81 a ton. The placer bullion reported by nine producers amounted to

$5,868 in gold and 8 ounces of silver, against a production of $10,911 in gold and 18 ounces of silver reported by 13 producers in 1918.

Cedar Creek district (*Iron Mountain, Quartz*).—The output of the Cedar Creek district from one deep mine and nine placers was valued at $16,052. Several hundred tons of copper ore was treated by concentration at the Amador mine, operated by the Intermountain Copper Mining Co. In 1917 and 1918 this property produced a large quantity of copper. The ore consists principally of chalcopyrite. For many years the placers in the vicinity of Quartz have produced unusually fine gold bullion. In 1919 the Dakota, Cedar Creek, Meadow Creek, Ohio Gulch, Stockholm, Sunrise, C. B. &. Q., and Windfall placers were productive. The Cedar Creek placer was formerly operated by dredging, but the plant has been removed. A 25-ton ball mill was installed at the Golden Sunset property, and the tunnel was driven 60 feet.

Saltese district.—At the Amazon Dixie mine, near Sildex, 1,000 feet of development work was done in crosscuts and drifts.

Spring Gulch district.—The Iron Mask mine, near Superior, produced a test lot of sulphide lead ore, containing silver.

Unorganized district.—Development work was continued at the Silver Cable mine, which is opened by 7,000 feet of drifts and tunnels.

MISSOULA COUNTY.

The output in Missoula County consisted of 8 tons of copper ore and 226 tons of siliceous ore; it was largely of milling grade and contained $1,185 in gold, 805 ounces of silver, 919 pounds of copper, and 1,697 pounds of lead, valued in all at $2,347. Nine placers produced bullion containing $1,343 in gold and 5 ounces of silver.

Coloma district (*Potomac*).—The output from one deep mine and three placers was valued at $1,526. Placer operations resulted in gold valued at $546 and 5 ounces of silver. One car of siliceous silver ore, containing lead, was shipped by the Royal Mining Co. Placer gold came principally from the Davey placer, on Elk Creek.

Copper Cliff district.—The Potomac Copper Co. did much development work in tunnels and crosscuts. A statement[14] by the company gives the following information:

> In No. 1 tunnel, which has been cleaned out and repaired, there is an exposure of ore sampling 6.4 per cent copper and 40 cents gold across a width of 5 feet. * * *
>
> The Copper Cliff shaft has been tapped and drained by No. 3 tunnel, and on the 150-foot level there is an exposure of ore which samples 4.4 per cent copper and $18 gold across a width of 4 feet.
>
> No. 3 tunnel has been cleaned out, repaired, and advanced to a point 1,200 feet from the portal. * * *
>
> No. 4 tunnel is being driven from the main gulch on Union Creek westerly to develop the veins cropping near the Copper Cliff and to cut the downward extension of the Copper Cliff itself.

Nine Mile district.—Six placers and one deep mine produced gold and silver valued at $1,972. Low-grade gold ore was treated by amalgamation at the Martina mine, and placer gold came from the Big Boulder, Chrysalis, Petty Creek, and Pine placers.

Wallace district.—One test lot of copper ore was shipped from the Jack Pot claim, near Clinton.

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[14] Potomac Copper Co. statement to directors, Jan. 1, 1920.

PARK COUNTY.

Siliceous ore (3,900 tons) and lead ore (86 tons) were mined in Park County. The siliceous ore was treated by amalgamation and produced gold bullion and a rich gold concentrate; the lead ore was shipped directly to smelters. Two placers produced $1,375 in gold and 6 ounces of silver.

Emigrant Creek district.—A little gold was won by drifting and sluicing operations on the Pittsburg property, in Emigrant Gulch.

New World district (Cooke).—Lead ore shipped from the New World district had a total value of $7,340, or an average of $85.35 a ton. The Great Republic mine was operated by the Old Republic Leasing & Exploration Co., and some development work was done which consisted of drifting and raising. Lead ore was also shipped by the Yellowstone Mining Corporation, which operated a property near Cooke. Considerable road building was done by the Glengary Mining Co., the successor to the Montana Scotch Bonnet Silver & Gold Mining Co. Ore will be hauled to Gardiner, a station on a branch line of the Northern Pacific Railway, 53 miles west of Cooke.

Sheepeater district (Jardine).—A large quantity of ore was treated by amalgamation and concentration by the Jardine Gold Mining & Milling Co. The ore is principally arsenopyrite, and most of the gold and silver is recovered in concentrate, which is smelted. About $20,000 was expended in 1919 in additional mill equipment, which consisted of James tables, Richard-Janey classifiers, Callow tanks, and Allis-Chalmers ball mill.

PHILLIPS COUNTY.

Little Rockies district.—Prior to 1918 the mines of the Little Rockies district produced much gold from ore which contained about $2 a ton in gold and silver. It was impossible to treat this class of ore profitably in 1919.

POWELL COUNTY.

The ore mined in Powell County was classified as 61 tons of siliceous ore, 289 tons of lead ore, and 81 tons of copper ore. Shipments directly to the smelters aggregated 247 tons and contained $2,602 in gold, 4,687 ounces of silver, 6,103 pounds of copper, and 50,705 pounds of lead, valued in all at $11,673. Ten placer producers reported $4,349 in gold and 27 ounces of silver in 1919, against $8,379 in gold and 57 ounces of silver reported by 15 operators in 1918.

Mary Ann district.—The output consisted of sulphide lead ore from the Gray Rock property and a small lot of silver ore from the Marian mine.

Ontario district (Elliston).—Five deep mines and one placer produced 255 tons of ore, $2,195 in gold, 1,853 ounces of silver, and 21,382 pounds of lead, valued in all at $5,403. Lead ore from the Monarch property, on the west side of Bison Mountain, was treated in a plant equipped for concentration and flotation. Several small lots of ore were shipped from the Big Dick, Black Jack, Lizzard, and Sterritt properties.

Ophir district (Finn).—The value of the district output from five placers and two deep mines was $1,016. The placer output con-

sisted of $592 in gold and 3 ounces of silver. Gold ore was shipped from the Fairview and Kennedy properties, near Avon.

Pioneer district (Gold Creek).—Four placers and one deep mine produced gold valued at $3,776 and 90 ounces of silver. Most of the gold resulted from operations at the Pioneer placer, and some gold was also saved at the Upper Gold Creek and Friday placers.

Snowshoe district.—Some sulphide copper ore was shipped from the Copper Wire and Arnold claims.

Zozell district (Deer Lodge).—A small lot of sulphide lead ore was shipped from the Blue Eyed May property, near Deer Lodge.

Unorganized district.—Copper ore, containing gold and silver, was shipped from the North Pole mine, which was under lease.

RAVALLI COUNTY.

Hughes Creek district.—Production from the Hughes Creek district, near Darby, consisted of placer bullion from sluicing operations by the Hughes Creek Dredging Co.

SANDERS COUNTY.

Three deep-mine producers reported the output of 59 tons of ore, containing gold, silver, and copper, valued in all at $4,323.

Revais Creek district (Dixon).—The Dixon mine produced one car of sulphide copper ore.

Thompson River district.—Two small lots of copper ore were shipped from the Copper Mask and Copper King mines, near Thompson Falls.

Trout Creek district.—The Vermilion Silver & Lead Mining Co. did 500 feet of tunnel work. A 100-ton mill on the property is equipped for concentration.

SILVER BOW COUNTY.

Mine production in Silver Bow County, Mont., in 1918 and 1919.

Year.	Number of producers.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Recoverable zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	75	7,394,038	$902,094	15,013,855	321,107,456	22,746,456	204,963,778	$115,496,193
1919	87	3,907,089	579,638	10,531,127	169,052,604	20,311,907	167,294,479	57,107,312
Increase or decrease, 1919	+12	−3,486,949	−322,456	−4,482,728	−152,054,852	−2,434,549	−37,669,299	−58,388,881

[a] Includes placer production.

Most of the output was produced by 12 companies. Although the total average value per ton of ore decreased, the gold and silver value increased. Decreases in output of metals in 1919 from both deep mines and placers are shown in the accompanying table. The largest part of the ore produced, 3,014,410 tons, and 380,335 tons of old tailings were concentrated at milling plants situated at Butte and Anaconda. The product consisted of copper concentrates, zinc concentrates, lead-zinc concentrates, lead concentrates, and siliceous concentrates, aggregating 1,128,373 tons and containing

$436,719 in gold, 8,973,788 ounces of silver, 138,380,794 pounds of copper, 20,311,907 pounds of lead, and 167,294,479 pounds of zinc, valued in all at $49,515,217, or an average of $43.88 a ton. The crude smelting ore amounted to 215,947 tons and contained $135,445 in gold, 1,477,821 ounces of silver, and 19,980,642 pounds of copper, valued in all at $5,507,004, or an average of $25.50 a ton. Only a few tons of ore was treated in gold and silver mills, but 18,665 tons of copper ore and 253,419 tons of old tailing were leached with sulphuric acid. The output of ore was classified as 3,079,222 tons of copper ore, 782,081 tons of lead-zinc ore, 44,766 tons of dry or siliceous ore, and 1,020 tons of lead ore. The placer output was $2,306 in gold and 14 ounces of silver, as against $3,012 in gold and 28 ounces of silver in 1918. Silver Bow County produced more than 93 per cent of the output of ore in the State, 26 per cent of the gold, nearly 84 per cent of the silver, more than 99 per cent of the copper, nearly 59 per cent of the lead, more than 99 per cent of the zinc, and more than 92 per cent of the total value.

Divide Creek district (Melrose).—Ten deep mines produced 137 tons of ore, containing $576 in gold, 3,656 ounces of silver, and 1,164 pounds of copper, valued in all at $4,886. All the ore was of shipping grade, and most of it was silver ore from the Horn Silver, Gold Dust, Climax, Combination, Pandora, and Lamarche properties.

German Gulch district.—Hydraulic mining at the Beal placer in German Gulch district resulted in a slight production of gold and silver.

Summit Valley or Butte district.[15]—Seventy-six mines in the Butte district produced 3,906,952 tons of ore and old tailing, which yielded $576,756 in gold, 10,527,457 ounces of silver, 169,051,440 pounds of copper, 20,311,907 pounds of lead, and 167,294,479 pounds of recoverable zinc, valued in all at $57,100,104, or an average of $14.62 a ton. Most of the ore, 3,014,410 tons, was milled, and 215,810 tons was smelted. In 1918 sixty-six mines in the Butte district produced 3,393,934 tons of ore and tailings valued at $115,489,876.

Since the beginning of activities in 1882 to the end of 1919 Silver Bow County, of which this district covers the largest part, has produced gold, silver, copper, lead, and zinc valued at $1,620,241,068, divided as follows: Gold, $30,871,745; silver, $250,058,148; copper, $1,213,839,547; lead, $5,312,706; and zinc, $120,158,922. The production of zinc began in 1905. The values given above are for 3,493,420.63 ounces of gold, 350,148,981 ounces of silver, 7,762,670,666 pounds of copper, 87,223,160 pounds of lead, and 1,283,213,943 pounds of recoverable zinc. A statement of the figures by years to 1913 may be seen in Mineral Resources for that year.

The mines of the Anaconda Copper Mining Co.[16] produced 2,103,099 tons of ore and 10,420 tons of precipitates, a total of 2,113,519 tons, against a total of 4,925,022 tons in 1918. The copper reduction works treated for all companies during the year 2,340,100 tons of ore and other cupriferous material at Anaconda. No copper ores were treated at Great Falls, except a small quantity of copper concentrates from Anaconda used for the fluxing of zinc plant residues.

[15] For discussion of geology see Weed, W. H., The geology and ore deposits of the Butte district, Mont.: U. S. Geol. Survey Prof. Paper 74, 1912; Sears, R. H., Ore deposits at Butte: Am. Inst. Min. Eng. Trans. vol. 46, pp. 3–106, 1914.

[16] Anaconda Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

Of the material treated at Anaconda 1,794,358 tons of ore was produced by company mines, 511,847 tons of ore was either purchased from or treated for other companies, and 33,895 tons was precipitates and cleanings from the old works at Anaconda and Butte. The Anaconda works produced 144,112,285 pounds of fine copper, 7,377,477 ounces of silver, and 42,525.78 ounces of gold. Of this production, 129,781,031 pounds of fine copper, 6,744,262 ounces of silver, and 30,000 ounces of gold were produced for the Anaconda Co. The electrolytic copper refinery at Great Falls produced, during the year, 129,022,057 pounds of cathodes, of which 121,338,737 pounds were melted into shapes at Great Falls. The copper-leaching plant at Anaconda treated, during the year, 184,700 tons of tailings and 61,400 tons of purchased ore, from which 2,500 tons of cement copper was produced. The copper concentrator also treated by flotation 44,500 tons of slimes from the ponds and 31,000 tons of old tailings. The zinc plants at Anaconda and Great Falls treated during the year 284,599 tons of ore and other zinciferous material, of which 191,419 tons was produced by mines of the Anaconda Co., and 93,180 tons of ore and concentrates was purchased from other companies. At Great Falls 48,459,727 pounds of electrolytic zinc was produced, 3,994,251 pounds of zinc in dross, and residue from which were produced 15,256,441 pounds of lead, 5,157,220 pounds of copper, 2,282,955.64 ounces of silver, and 7,150.11 ounces of gold. Of the copper output 43,241,497 pounds was rolled into rods, of which 13,914,008 pounds was made into wire. Dividends paid in 1919 by the Anaconda Co. amounted to $9,325,000. The company report continues:

The beginning of the year found the nonferrous metal industries in a state of profound depression. The production of copper, lead, and zinc, which, during the war period had reached unprecedented outputs, was necessarily sharply curtailed to enable the consumption of stocks and the reestablishment of these industries upon a stable basis.

During the year the consumption of copper in domestic business rapidly increased and since the first quarter has been conducted upon a scale far in excess of any previous peace-time period. * * *

Due to many of the mines being idle on account of curtailed operations, the amount of development and exploration work done during the year 1919 was considerably reduced as compared with previous years.

During the year there was done in the mines of the company in the form of drifts, crosscuts, upraises, shafts, and winzes, 20.39 miles of development, as compared with 41.85 miles in the year 1918. The shafts of the company were sunk additional depths aggregating 1,749 feet.

The shaft on the Orphan Girl claim was sunk to a depth of 1,036 feet. A station was cut at this point and a crosscut was started in a northerly direction to cut the veins apexing on the Orphan Boy and the Anglo-Saxon claims.

The results obtained from the development and exploration work in the mines of the company throughout the year were quite satisfactory.

Notwithstanding the fact that development and exploration were somewhat curtailed, a large amount of repair work was performed. * * *

The plan of ventilation which was undertaken by the company a year ago was carried on, and the results are most gratifying. Ten electrically driven fans were installed on surface having a capacity of 1,100,000 cubic feet. Six fans were installed underground, while 87 blowers were installed in the different mines. * * *

The fireproofing of the High Ore shaft was completed during the year, and the work of fireproofing the Moonlight, Tramway, Mountain View, Pennsylvania, and Leonard mines was continued. * * *

The smoke-treatment plant at Anaconda, consisting of 20 Cottrell treater units, was put into commission during the year. It has been demonstrated that this plant is capable of producing the results expected from it; conditions within the smelting plant have been improved, owing to the increased draft available from the new stack. The old stack was dismantled.

The special reverberatory furnace, with its treaters, was completed during the year and is smelting all of the dust from the main treaters as well as dust from a stock pile which had accumulated. The new plant is making a satisfactory recovery of copper, silver, gold, and arsenic contained in the dust.

Construction of an arsenic-refining plant capable of producing 400 tons per month of refined arsenic was begun and partially completed during the year. This when completed will refine the crude arsenical dust from the treaters connected with the special reverberatory.

The earth dams for impounding tailings, which were begun during 1918 as a part of the program of improving conditions around the reduction works, were practically completed, and have been in commission for several months. All of the muddy water from the concentrator and reduction works is now being settled and a clear overflow is being maintained. * * *

The experimental 25-ton tower acid plant was completed and was operated with very satisfactory results. This new system of acid making has been demonstrated to be an unqualified success and will be used in connection with the production of acid for the treatment of phosphate rock at Anaconda.

The erection of an experimental 50-ton phosphate plant was begun, and this plant when completed will treat about 50 tons of phosphate rock per day and will produce about 35 tons of a product which will be placed upon the market under the name of "Treble Acid Phosphate" and will contain about 48 per cent of soluble phosphoric acid.

The mines of the Anaconda Co. are considered one large property, as many of them are connected underground. The mines in operation in 1919 were the Anaconda, Never Sweat, St. Lawrence, Mountain Consolidated, Bell-Diamond, High Ore, Belmont, Original, Stewart, Moonlight, Poulin, Tramway, Silver Bow, Berkeley, West Gray Rock, Mountain View, Pennsylvania, Leonard, West Colusa, East Colusa, Badger State, Tropic, Nettie No. 3, Lexington, Bonanza, Orphan Girl, Gold Hill, and Orphan Boy. A detailed description of the mines and works is given by Weed.[17]

From the North Butte property[18] 294,318 wet tons of ore and 13¾ wet tons of precipitates were shipped, and 287,787 dry tons of ore and 12¾ dry tons of precipitates were treated at the smelter at Anaconda. Of this ore, 1,210 tons, or 0.5 per cent, was first class; 278,347 dry tons, or 96.6 per cent, second class; and 8,230 dry tons, or 2.9 per cent, third class. The production was 14,331,254 pounds of fine copper, 633,214.82 ounces of silver, and 914.07 ounces of gold. The report continues as follows:

The year's production was about 60 per cent of the normal output of the mines. All of the ore mined was handled through the Granite Mountain shaft, which operated throughout the year, with the exception of three weeks in December, when the smelter could not receive ore owing to the nation-wide coal strike. The Speculator shaft was idle nearly the entire year, but necessary repairs to both shaft and hoist were made during the period of suspension. At several points in the shaft where the ground is heavy, timbering has been replaced by concrete. With the completion of the work under way there will be a total of about 500 feet of concrete in the Speculator shaft between the 1,200 level and the surface.

Adequate development work was maintained throughout the year. The results were quite satisfactory, as will be observed by reference to the detailed report of the general manager. New development of the Edith May vein at deeper levels has been especially promising. On the 3,200 level ore for a distance of 282 feet averaged 8 feet in width, assaying 4.9 per cent copper, and 2.5 ounces of silver per ton. Development results are reflected in the improved grade of shipments, there having been only 2.9 per cent third-class ore shipped in 1919, as compared with 17.19 per cent in 1918.

Standardization of underground methods and the efforts of the management to strengthen mutual respect and confidence between employees and the operating staff have been fruitful of good results. Underground conditions are made as health-

[17] Weed, W. H., Mines Handbook, vol. 14, pp. 959-971, 1920.
[18] North Butte Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

ful, comfortable, and convenient as possible and studies are constantly being made to improve them. Faithful and efficient effort is recognized and rewarded by bonus payments added to the standard daily wage. The employees have met this policy in a spirit of friendly cooperation and there has resulted a marked advance in operating efficiency.

The cost of production was 14.85 cents per pound, including all expenses and depreciation, but not ore depletion, and deducting value of gold and silver. This compares with 20.917 cents per pound in 1918. The improvement is due to the higher grade of ore mined, higher price of silver, and increased operating efficiency.

On the East Side properties the principal work was done on the 900 level of the Sarsfield shaft. After driving through the Continental fault crosscuts were run north and south to the boundaries of the company's ground lying west of the fault. Several well-defined veins were cut and followed by drifting, but while they carried some copper values no commercial ore was opened up. The south crosscut passed through a considerable area of intense fracturing, quite strongly mineralized. The formation here is a stockwork of pyrite seams in quartz porphyry, carrying fractional copper values. A 200-foot raise was run in this quartz porphyry with a crosscut from the top. The copper values in the upper crosscut were higher, although not sufficient to constitute payable ore. * * *

Toward the end of the year work was started on the Bertha claim, where there is a promising deposit of siliceous ore. The shaft was retimbered to the 100-foot level and suitable surface equipment installed. The first shipment yielded smelter returns of 2.25 per cent copper.

The condition of the copper metal market on the whole was quite unsatisfactory throughout the year. Sales of copper were erratic and selling prices lower than the prices of any other basic raw material. This was largely due to the fact that at the beginning of 1919 there was on hand a larger surplus of unsold copper than at any previous time in the history of the industry.

Gross income was $3,584,776 and expenditures $3,021,368, including $1,877,578 for mining and development, $51,004 for freight, and $900,059 for concentrating, smelting, refining, and selling.

The East Butte Copper Mining Co.[19] operated the 500-ton copper smelter and 1,200-ton concentration-flotation plant east of Butte. The mine was in operation full time, but the smelter was idle 21 days. In 1919 the mill and smelter treated 143,654 tons of company ore and 79,818 tons of custom ore. The work resulted in a production of 1,013 ounces of gold, 698,146 ounces of silver, and 19,987,733 pounds of copper, a decrease in the copper output of about 18 per cent from that of 1918. The gross value of the metals shipped was $4,152,216, net surplus $524,188, and dividends $210,366. The price received for copper was 18.6856 cents a pound, and the cost of production was 16.5821 cents a pound. The report continues:

A comparison of the statement of operations with that of previous years shows a number of interesting changes. Production for the year amounted to 146,000 tons of ore averaging 3.70 per cent copper, as compared with 184,000 tons averaging 4.15 per cent for the previous year. However, the cost of mining averaged $6.14 per ton of ore mined for the year, as compared with $9.02 for 1918, $8.58 for 1917, and approximately $5.00 for prewar times.

Production for the year was won from the various levels in the following proportions: Eighth level and above, 28 per cent; tenth level, 10.6 per cent; twelfth level, 22.5 per cent; fifteenth level, 22.1 per cent; eighteenth level, 16.8 per cent. * * *

The proportion of first-class ore produced shows a marked falling off from that produced during former years. For 1919 the total production of first class amounted to 24,018 tons averaging 7.55 per cent, while for 1918 it amounted to 50,304 tons averaging 7.31 per cent.

Exploratory work for 1919 amounted to 6,303 feet of crosscuts, drifts, and upraises, and is practically the same in proportion to the amount of ore mined as was done in 1918. As a result of this work, there has been developed an amount of ore estimated to be somewhat in excess of the amount mined and removed during the year. Of the new ore developed, however, the proportion of first class is materially less than was

[19] East Butte Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1919.

the proportion of first-class mined during the year. Approximately 50 per cent of the new ore developed was opened up on the fifteenth and eighteenth levels.

While the ore reserves of the property are holding out remarkably well, and while deeper workings are adding to these resources in a very material way, it can not be denied that the ore bodies being discovered on the deeper levels are not as wide and extensive and are not as high in average copper content as those on higher levels. It is true, furthermore, that the total final ore reserves in the property are depleted annually by the amount of the ore removed.

The Tuolumne Copper Mining Co.[20] produced in 1919 from the Main Range mine in 314 operating days 26,515 dry tons of ore which had an average assay of 0.0075 ounce of gold, 8.128 ounces of silver, and 2.094 per cent of copper. The total contents were 199.4 ounces of gold, 215,520 ounces of silver, and 1,110,286 pounds of copper, for which the company received $217,553 from the smelter. The printed report continues:

Development consisted of 425 feet in the three-compartment shaft, 1,931 feet of crosscutting, 999 feet of drifting, and 13,640 cubic feet of station cutting.

The Main Range shaft has been sunk from the 800-foot level to the 1,200-foot level. On the 1,000-foot level a crosscut has been driven to the Spread Delight vein and 590 feet of drifts have been driven on the vein. The Spread Delight vein on the 1,000-foot level is strong and well mineralized. The ore shoot developed on the levels above has been opened on the 1,000 and, though smaller, carries a higher relative silver content. The vein is thoroughly leached and the ore bodies have been considerably displaced on the 1,000 level by faulting. The ratio of silver values to those of copper is higher on the 1,000 level than on the levels above, and this fact together with the fact that the vein on this level shows abundant evidence of leaching throughout is conclusive evidence that greater depth will be required to open and develop large shoots of sulphide ore. At present a raise is being driven from the 1,000 level to the 800 level on the ore body developed. The ore produced from this development shows silver values up to 30 ounces, but the average values are less than 15 ounces silver and 2 per cent copper. On the 1,000 sill ore was encountered which sampled over 70 ounces of silver across a width of 6 feet.

On the 1,200 level a crosscut is being driven south from the Main Range shaft. This working has cut the Spread Delight vein 300 feet to the east of the ore shoot developed above and is being continued south to cut the Rory O'More vein. The Spread Delight vein on the 1,200 level shows less quartz and contains a more promising vein filling than on the 1,000. * * *

Operating expense for the past year amounts to $306,277.05, exclusive of depreciation, and of which $145,000 was expended for development and permanent equipment, or of the total operating expense, 47.3 per cent was charged to development and permanent equipment.

The present production of the mine, amounting to approximately 100 tons per day, is from the 700 and 800 stopes and the development work being conducted on the 1,000-foot level.

While the expectation of the management has not been fulfilled in the development thus far of the 1,000-foot level in that ore of primary character containing a higher relative copper content to that of the silver would be disclosed, the general character of the vein, its strength and persistence, and the more general mineralization of the vein on this level as compared to the 800, is very encouraging. It must be remembered that bedrock on this property is covered by from 300 to 400 feet of wash, consisting of material eroded from the higher slopes to the east, and that the depth below bedrock attained by the 1,000 level is in reality only about 600 feet. * * *

It is the recommendation of your management that the sinking of the Main Range shaft be resumed at the earliest possible date and that it be continued to the 2,000-foot level, and that crosscuts be driven simultaneously on the 1,600 and 2,000 foot levels to the Spread Delight and Rory O'More veins. Following the development of these levels the 1,400 and 1,800 foot levels can be opened and the property worked on a larger tonnage basis than is possible in developing single levels.

The Butte & Superior Mining Co.[21] produced 403,436 tons of milling ore, a decrease from the output of 1918. The mill recoveries for the year averaged 95.523 per cent of the zinc contents. The direct cost

[20] Tuolumne Copper Mining Co. Ann. Rept. for year ending Dec. 31, 1919.
[21] Butte & Superior Mining Co. Eighth Ann. Rept. for year ending Dec. 31, 1919.

of milling was $2.74 a ton of ore, a decrease of 18 cents a ton. The revenue from the sale of concentrates and residues was $5,912,640. Freight cost $1,051,470, mining $2,542,758, milling $1,106,796. The net income after deductions for taxes, depletion, etc., was $864,990. The report continues:

Although the tonnage treated in 1919 was considerably less than that for 1918 and the grade of ore lower, the financial results of operations show an increase as compared with the previous year. This increase is mainly due to the high price of silver prevailing during the year, and the increased working efficiency which brought about a considerable decrease in mining and milling costs.

The average price of spelter under which settlements were made for the year was 7.1446 cents, as compared with 7.7572 cents for 1918, a decrease of 0.6126 cent.

The estimate of developed ore reserves as of December 31, 1919, shows 623,300 tons, as compared with the estimate of 830,000 tons as of December 31, 1918, the decrease being largely accounted for by the consent decree in the Apex litigation, whereby your company relinquished some of its developed ore.

As previously stated in the quarterly reports, the trial of the case involving extralateral rights between the Elm Orlu and Black Rock claims was commenced at Butte on August 4, 1919, and continued until August 23, on which date a compromise agreement was reached between the parties and a consent decree entered. By the terms of the settlement, the title of the Clark Montana Realty Co. was quieted to the Jersey Blue vein below the 1,300-foot level of the Black Rock and west of a plane drawn parallel to the west end line of the Elm Orlu claim through a point 487 feet easterly of the southwest corner of the Black Rock claim along the common side line. The title of the Clark Montana Realty Co. was also quieted to the Rainbow lode west of said 487-foot plane to the 301-foot plane and below a horizontal plane drawn at an elevation of 4,859.5 feet above sea level (approximately the 1,200-foot level Black Rock mine).

In addition, the Butte & Superior Mining Co. paid the Clark Montana Realty Co. $2,500,000 in full settlement for all damage claims and for all profits on ores extracted east of such 301-foot plane, and in turn the Clark Montana Realty Co. subrogated the Butte & Superior Mining Co. to certain of its rights. This settlement quieted title in the Butte & Superior Mining Co. to all of the Jersey Blue vein above the 1,300-foot level at all points westward of such 487-foot plane and to all depths eastward of such plane of the Black Rock, and to all of the Rainbow lode apexing within the Black Rock claim at all points above the horizontal plane at the 4,859.5-foot elevation. Title was quieted also in the Butte & Superior Mining Co. to the Rainbow lode and all other veins at all depths eastward of the 487-foot plane, except only such south or west dipping veins as apex in the Elm Orlu claim, in both the Black Rock and the Elm Orlu claims at all depths to the east of the 487-foot plane.

By virtue of this settlement and of a decree, which had the declared effect of an exchange of property by grant and conveyance, all of the apex controversy between the Black Rock and Elm Orlu claims is fully settled and this litigation finally ended.

In the litigation of the Mineral Separation (Ltd.) vs. Butte & Superior Mining Co., the Supreme Court of the United States on June 2, 1919, rendered a decision reversing and modifying the decisions of the Circuit Court of Appeals for the Ninth Circuit and the United States District Court for the District of Montana. The substance of the decision of the Supreme Court of the United States was that, when the Butte & Superior Mining Co. was using a fraction of 1 per cent of oil on the weight of the ore, it was infringing the patent of the Mineral Separation (Ltd.), and that when it was using 1 per cent or more of oil on the weight of the ore it was not infringing the patent of the Mineral Separation (Ltd.). * * *

No. 1 shaft was operated in a limited way during the first and second quarters for the purpose of handling supplies in connection with litigation work on the upper levels and stoping operations on the 800-foot level. * * *

During the year the No. 2 shaft was completed to the 2,050-foot level, and preparations were being made at the end of the year for the further sinking of this shaft an additional 300 feet below the 2,050 level and raising on No. 3 shaft to connect it also to the 2,350 level.

No. 3 shaft was in continuous operation during the entire year, and all ore was hoisted through this shaft. No repairs of any importance were required in this shaft during the year. * * *

There was recorded during the year 11,879 feet of drifting, 6,448 feet of crosscutting, 2,699 feet of raises and winzes, and 43 feet of stations, or a total of 21,069 feet, exclusive of 1,793 feet of diamond drilling. * * *

The estimate of ore reserves as of December 31, 1919, shows 623,300 tons averaging 16.7 per cent zinc and 5.7 ounces of silver, as compared with the estimate of 830,000 tons at December 31, 1918, averaging 17 per cent zinc and 5.7 ounces of silver. The decrease is accounted for partly by the consent decree in Apex litigation with the owners of the Elm Orlu claim, whereby your company lost a considerable tonnage of developed ore, and also by the delay in regular development resulting from this litigation. * * *

The direct cost of mining 404,258 tons of ore during the year was $6.29 per ton, as compared with $7.19 per ton for the previous year, or a decrease of 90 cents per ton. The average grade of ore was slightly lower than the grade for the previous year, showing a decrease of 0.09 ounce of silver and 1.33 per cent zinc. * * *

During the year very satisfactory improvement was made in metallurgical results, the principal feature being an increase in the average zinc content of concentrates of 3.145 per cent, in the average silver content of 1.14 ounces, and in the average recovery of 2.563 per cent, as compared with the results of the previous year.

Crude ore treated and concentrates produced at Butte-Superior mill in 1919.

Ore and product.	Quantity.	Gold.		Silver.	
		Total content.	Average per ton.	Total content.	Average per ton.
	Short tons.	*Ounces.*	*Ounces.*	*Ounces.*	*Ounces.*
Crude ore, milled	403,436	4,128.418	0.0102	2,521,413.92	6.2498
Zinc concentrate	104,198	3,545.861	.0340	2,205,824.55	21.1690
Lead concentrate	1,729	76.780	.0444	42,293.43	24.4610
Lead-zinc middlings	384	12.093	.0315	6,368.36	16.5840

Ore and product.	Copper.		Lead.		Zinc.	
	Total content.	Average per ton.	Total content.	Average per ton.	Total content.	Average per ton.
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
Crude ore, milled	1,134,025	0.141	10,874,039	1.348	118,591,220	14.698
Zinc concentrate	1,010,201	.485	8,184,940	3.928	113,287,464	54.362
Lead concentrate	7,638	.221	1,587,018	45.894	329,853	9.539
Lead-zinc middlings	2,027	.264	99,055	12.898	221,406	28.829

The Emma mine,[22] owned by the Butte Copper & Zinc Co. and leased to the Anaconda Copper Mining Co., was active about seven months. Lead-zinc ore was shipped to Anaconda for milling, and concentrates were treated at Great Falls. The mine also contains a large deposit of manganese ore.[23] The following paragraphs are taken from the company's report:

The results from operations of your company during the past year have been as satisfactory as conditions warranted. During the early part of the year, a fine zinc ore body, rich in silver, lead, and zinc, was opened up on the 1,000-foot level of the company, its deepest shaft workings, and from this we were extracting a quantity of good ore, which was bringing up the grade of your shipments. In addition to the above, some good ore bodies were opened up on the intermediate levels.

The price of metals during the first half year was low and our returns were cut down by this. The result of operations up to July 1 showed a net profit of $36,900, after payment of about $16,000 taxes.

Since August the mine of your company has been closed down, due first to the unsettled labor conditions in Butte, and next to the Anaconda Co. closing down its zinc plant at Great Falls on account of a large surplus of zinc on hand in this country. During the year this zinc surplus was largely consumed and the Anaconda Co. decided to resume the operation of its zinc plant to 50 per cent of its normal capacity. The coal shortage, however, delayed the resumption of operations until

[22] Butte Copper & Zinc Co. Third Ann. Rept., for year ending Dec. 31, 1919.
[23] Pardee, J. T., Manganese at Butte, Mont.: U. S. Geol. Survey Bull. 690, pp. 111–130, 1919.

late in December, when your mine was again started, and the intention of the Anaconda Co. is to bring the production up to 250 tons daily.

We are now considering the possibility of running a crosscut from the bottom of the Ophir snaft, a distance of nearly 1,600 feet, to get under the Emma ore bodies at a depth of 1,200 feet and prospect the ground at that depth. The time for the redemption of the Ophir having expired at the end of October, and the property not having been redeemed, became ours and should prove of great value to our company, enabling us to greatly increase our production of ore, as well as cutting off the hauling charges to the railroad.

Your mine in Butte can be developed within a short time to furnish a large portion of all the manganese required in America and, because of its being a carbonate ore with high manganese and low silica content, it is particularly desirable. Naturally, by reason of the closing down of our properties for nearly six months of the year and of our paying one-half the expenses of keeping the properties up, the results of the past year showed a loss.

The Elm Orlu mine was active in 1919, though at a somewhat reduced rate. Lead-zinc ore was milled at the Timber Butte mill, south of Butte, and copper ore was shipped to Anaconda. Zinc concentrate at the rate of more than 3,000 tons a month was shipped to eastern zinc smelters and to the electrolytic zinc plant at Great Falls, and lead concentrate was smelted at East Helena. As a result of the settlement of the lawsuit with the Butte & Superior Mining Co., the Clark Montana Realty Co., controlling the Elm Orlu mine, received $2,500,000. The history of the case with a plan of the area in conflict was given in the press [24] in September. Unfortunately the company issues no printed report. Other properties controlled by the Clark interests, which were productive in 1919, were the Moulton, Anselmo, Poser, and Butte Reduction Works' dump. The Moulton produced silver ore and a considerable quantity of lead-zinc ore. The Poser and Anselmo produced siliceous silver ore. A large production of copper, silver, and gold resulted from the smelting of flotation concentrate made at the Timber Butte mill from old tailing of the Butte Reduction Works' dump.

Oxidized copper ore from the Butte & Duluth and the Bullwhacker mines continued to be shipped to Anaconda, where it is treated in the copper-leaching plant, but the quantity produced at the Bullwhacker was much less than that of 1918.

The Davis Daly Copper Co. operated the Colorado mine, in the center of the city of Butte, and the Hibernia mine, 2 miles west of Butte. A summary of the quarterly reports of the company gave the following information for the year 1919: The Colorado mine produced 68,934 tons of copper ore, containing 410,802 ounces of silver and 10,350,196 pounds of copper, or an average of about 7.94 per cent of copper. A dividend of $300,000 was paid in December. Development work consisted of 2,946 feet of drifts, 1,738 feet of crosscuts, and 2,437 feet of raises. Receipts from ore sold amounted to $1,651,627. Cost for development was $295,286, mining $568,176, equipment $84,105, and general expenses $102,710, a total of $1,050,277. The Hibernia mine also produced several thousand tons of siliceous silver ore, but the output was not published. The reports [25] for the last two quarters of the year say:

Shaft sinking has been completed to a depth of 2,800 feet and a station has been started on the 2,700-foot level. Crosscutting will be started at once to intersect the ore bodies encountered on the 2,500-foot level. This will take approximately six

[24] Lytzen, W. W., The Elm Orlu *v.* Butte & Superior apex litigation: Min. and Sci. Press, vol. 119, pp. 364–368, 1919.

[25] Davis Daly Copper Co. Quarterly reports for periods ending Sept. 30 and Dec. 31, 1919.

or seven months. The new skip has arrived at Butte and the concrete foundations have been finished. The new ore bins at the collar of the shaft are being erected and it has been decided to extend these ore bins to a capacity of 600 tons for storage, and also to construct an ore-sorting plant which will prove of great value and economy. The haulage tunnel has been completely overhauled and grade changed, which necessitated removing much of the dump which has been a problem to your management. * * *

Crosscutting on the 2,700-foot level has progressed at the rate of about 5 feet per day and is now in 144 feet from the shaft. Indications from this development are that the same veins found on the 2,500 level will be intersected on the 2,700-foot level. * * *

The new steel ore bins at the collar of the shaft were put into operation December 6. This will add materially to the storage capacity and maintain steadier production. The new tunnel from the shaft to the street is a great improvement, which facilitates the transportation of ore from mine to railroad. A gasoline locomotive has been ordered, to be used for hauling ore from mine to railroad cars; this will be a decided step in the line of efficiency by displacing horses and men, besides greater speed in transportation. * * *

The Butte Ramsdell Copper Mining Co. shipped a large quantity of copper ore to the East Butte smelter and did 1,240 feet of development work. Several thousand tons of silver ore was shipped from the Blue Bird, Elba, Goldsmith, Isele, Republic, Brittania, and Amy mines. Other properties in the Butte district which produced shipping ore aside from small lots were the Lizzie, Plutus, Tzarina, Eagle, Hattie Bell, Illinois, Naomi, and Snowflake mines. At the Great Butte property 1,000 feet of development work was done in drifts and crosscuts.

COPPER.

By H. A. C. Jenison.

INTRODUCTION.

The production of metallic copper from the ore for industrial consumption requires at least three distinct operations—mining, smelting, and refining. Each of these operations embraces several processes, of which the preparation of the ore for smelting is ordinarily the most varied and complicated. The Lake Superior native-copper ores are the only important American source of copper in which the three operations are not necessary for the production of commercial copper. On account of these three operations it is possible to determine approximately the production of copper in the United States by the collection of mine statistics, smelter statistics, or refinery statistics. These three sets of statistics can never agree exactly, but each set has a peculiar advantage, and the coordination of all three accurately determines the essential features of the copper industry for the year.

The principal value of the mine statistics is that they determine most accurately the geographic distribution of production. They are also the only source of accurate data on the character of the ore, the copper and precious-metal contents of the ore, and the degree to which the ore is concentrated before smelting. They show the quantity of ore shipped from the mines, but are less accurate than the smelter figures in that they represent the estimated recoverable copper content and not the actual recovery. The smelter statistics show with fair accuracy the geographic distribution of the production and give accurately the quantity of crude copper actually recovered from the ores, including considerable copper from sulphur, lead, zinc, and siliceous ores that carry so little copper that the mines are not paid for it and frequently do not report it. The smelter figures also differ from the mine figures by the quantity of ore, matte, and other materials in stock at the beginning and at the end of the year. The refinery statistics indicate the quantity of copper made available for industrial consumption and the quantity of precious metals recovered from copper ore, but do not permit accurate distribution of production according to source, even the separation of production according to foreign and domestic sources being uncertain. The refinery figures differ from the smelter figures by the quantity of stocks of unrefined copper at the beginning and the end of each year

The principal cause of the differences in the figures from the three different sources is the time factor involved in the successive stages

of the production of refined copper. The interval from the time the ore is mined until the refined copper is available for commercial use is about three months. Consequently, whereas the mine figures represent the quantity of copper actually mined each calendar year, the smelter and refinery figures represent the quantity of copper produced during that year from ore part of which was mined in the last part of the preceding calendar year. The differences among the three sets of figures, however, should not be very great for any single year when the industry is normal.

As the smelter statistics permit accurate geographic distribution as to source and also represent the actual production of the copper, they are adopted in this report as showing the production of the country. They include the production of blister copper and the furnace-refined or Lake copper.

SUMMARY OF DOMESTIC AND WORLD STATISTICS.

Summary of statistics of the copper industry in the United States, 1913–1919.

	1913	1914	1915	1916
Production of copper:				
Smelter output.....pounds..	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548
Mine production.....do....	1,235,569,727	1,148,431,437	1,488,071,528	2,005,875,312
Refinery production of new copper—				
Electrolytic.....pounds..	1,022,497,601	991,573,073	1,114,345,342	1,579,620,513
Lake.....do....	155,715,286	158,009,748	236,757,062	269,794,531
Casting and pig.....do....	58,611,026	60,840,368	36,603,119	39,337,155
Total domestic.....do....	1,236,823,913	1,210,423,189	1,387,705,523	1,888,752,199
Total domestic and foreign....do....	1,615,067,782	1,533,781,394	1,634,204,448	2,259,387,315
Total new and old copper.....do....	1,888,000,000	1,790,000,000	2,027,000,000	2,959,000,000
Total ore produced.....short tons..	36,361,101	35,187,118	43,415,133	57,953,357
Copper ore produced.....do....	36,336,682	35,175,541	43,404,182	57,863,365
Average yield of copper.....per cent..	1.67	1.60	1.66	1.70
Average price per pound.....cents..	15.5	13.3	17.5	24.6
Imports (unmanufactured).....pounds..	408,778,954	306,350,827	315,698,449	462,335,980
Exports of metallic copper[a].....do....	926,241,092	840,080,922	681,917,855	784,006,486
Consumption:				
Total new copper.....do....	812,268,639	701,624,158	1,136,618,187	1,478,881,871
Total new and old copper.....do....	1,085,000,000	958,000,000	1,529,000,000	2,179,000,000
World's production.....do....	2,181,253,000	2,054,090,000	2,377,375,000	2,992,046,000
Value of production in the United States....	$189,795,035	$152,968,000	$242,902,000	$474,288,000

	1917	1918	1919
Production of copper:			
Smelter output.....pounds..	1,886,120,721	1,908,533,595	1,286,419,329
Mine production.....do....	1,895,434,349	1,910,022,841	1,212,334,041
Refinery production of new copper—			
Electrolytic.....do....	1,452,744,593	1,560,327,422	1,233,994,324
Lake.....do....	268,508,091	231,096,158	177,594,135
Casting and pig.....do....	152,293,487	91,450,611	21,897,336
Total domestic.....do....	1,873,546,171	1,882,874,191	1,433,485,795
Total domestic and foreign.....do....	2,428,546,171	2,432,385,290	1,805,306,801
Total new and old copper.....do....	3,195,000,000	3,138,000,000	2,380,000,000
Total ore produced.....short tons..	58,514,325	62,304,767	36,139,254
Copper ore produced.....do....	58,482,694	62,289,069	36,121,622
Average yield of copper.....per cent..	1.60	1.51	1.65
Average price per pound.....cents..	27.3	24.7	18.6
Imports (unmanufactured).....pounds..	556,420,297	575,805,115	429,387,594
Exports of metallic copper[a].....do....	1,125,647,336	744,243,481	515,595,019
Consumption:			
Total new copper.....do....	1,394,829,715	1,661,669,576	914,471,572
Total new and old copper.....do....	2,162,000,000	2,367,000,000	1,489,000,000
World's production.....do....	3,137,719,000	(b)	(b)
Value of production in the United States....	$514,911,000	$471,408,000	$239,274,000

[a] Total exports o copper, exclusive of ore, concentrates, and composition metal.
[b] Figures not yet available.

Copper produced in the United States from domestic ores, 1913–1919.

[Smelter output, in pounds fine.]

State.	1913	1914	1915	1916	1917	1918	1919
Alaska	23,423,070	24,985,847	70,695,286	113,823,064	84,759,086	67,081,648	56,534,992
Arizona	404,278,809	382,449,922	432,467,690	694,847,307	719,035,514	769,521,729	536,515,368
California	32,492,265	29,784,173	37,658,444	43,400,876	44,933,846	44,150,761	23,548,698
Colorado	9,052,104	7,316,066	7,272,178	9,536,193	10,054,951	7,591,570	4,892,558
Georgia	.....	.....	.....	803,699	930,691	397,078	8,306
Idaho	8,711,490	5,875,205	6,217,728	7,248,794	6,446,224	5,836,795	3,966,655
Maine	.....	.....	.....	.....	34,872	501,169	376,186
Maryland	.....	12,248	15,426	126,965	291,501	.....	.....
Michigan	155,715,286	158,009,748	238,956,410	269,794,531	268,508,091	231,096,158	177,594,135
Missouri	576,204	53,519	306,406	377,575	407,141	232,073	588,570
Montana	285,724,467	236,805,845	268,263,040	352,139,768	276,225,977	326,426,761	176,289,873
Nevada	85,209,536	60,122,904	67,757,322	100,816,724	115,028,161	106,266,603	64,683,734
New Jersey	.....	.....	.....	4,115	.....	.....	.....
New Mexico	50,196,881	64,204,703	62,817,234	79,863,439	107,593,615	96,559,580	60,377,320
North Carolina	180	19,712	33,383	5,961	125,004	79,200	3,334
Oregon	77,812	5,599	797,471	2,433,567	1,105,097	2,630,499	2,808,017
Pennsylvania	245,337	422,741	.....	904	115,000	34,500	.....
South Carolina	.....	.....	.....	.....	210,000	.....	2,297
South Dakota	.....	.....	.....	.....	.....	.....	(a)
Tennessee	19,489,654	18,661,112	18,205,308	14,556,278	16,093,757	15,053,568	15,629,454
Texas	39,008	34,272	38,971	86,463	2,061,129	13,851	2,153
Utah	148,057,450	160,589,660	175,177,695	232,335,950	227,840,447	230,964,908	143,836,304
Vermont	5,771	.....	23,995	324,400	102,522	896,630	582,561
Virginia	46,961	17,753	50,008	1,066,143	146,912	1,248	.....
Washington	732,742	683,602	903,661	2,473,481	2,051,416	2,330,568	2,552,134
Wyoming	362,235	17,082	351,871	1,784,351	2,019,767	866,698	150,051
Undistributed	46,836	65,479	.....	.....	.....	.....	15,476,629
	1,224,484,098	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595	1,286,419,329

(a) Included under "Undistributed."

Principal features of the copper industry, 1907–1919.

Year.	Refined copper, primary.	Secondary copper.	Smelter production, domestic ores.	Imports, in unmanufactured form.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1907	1,032,500,000	.....	869,000,000	253,000,000
1908	1,138,000,000	.....	942,500,000	219,000,000
1909	1,391,000,000	.....	1,093,000,000	322,000,000
1910	1,422,000,000	.....	1,080,000,000	344,000,000
1911	1,434,000,000	214,000,000	1,097,000,000	335,000,000
1912	1,568,100,000	275,000,000	1,243,000,000	410,000,000
1913	1,615,100,000	273,000,000	1,224,000,000	409,000,000
1914	1,533,800,000	256,000,000	1,150,000,000	306,000,000
1915	1,634,200,000	392,000,000	1,388,000,000	316,000,000
1916	2,259,400,000	700,000,000	1,928,000,000	462,000,000
1917	2,428,500,000	767,000,000	1,886,000,000	556,000,000
1918	2,432,400,000	705,000,000	1,908,500,000	576,000,000
1919	1,805,300,000	574,000,000	1,286,000,000	429,000,000

Year.	Exports of metallic copper.	Domestic consumption (new copper).	Average yearly price per pound.	World's production.
	Pounds.	*Pounds.*		*Pounds.*
1907	509,000,000	488,000,000	$0.200	1,595,553,000
1908	662,000,000	480,000,000	.132	1,640,200,000
1909	683,000,000	689,000,000	.130	1,824,476,000
1910	708,000,000	732,000,000	.127	1,892,252,000
1911	786,500,000	682,000,000	.125	1,961,516,000
1912	775,000,000	776,000,000	.165	2,205,012,000
1913	926,000,000	812,000,000	.155	2,181,253,000
1914	840,000,000	702,000,000	.133	2,054,090,000
1915	682,000,000	1,137,000,000	.175	2,377,375,000
1916	784,000,000	1,479,000,000	.246	2,992,046,000
1917	1,126,000,000	1,395,000,000	.273	3,137,719,000
1918	744,000,000	1,662,000,000	.247	(a)
1919	516,000,000	914,000,000	.186	(a)

(a) Returns incomplete. See p. 542.

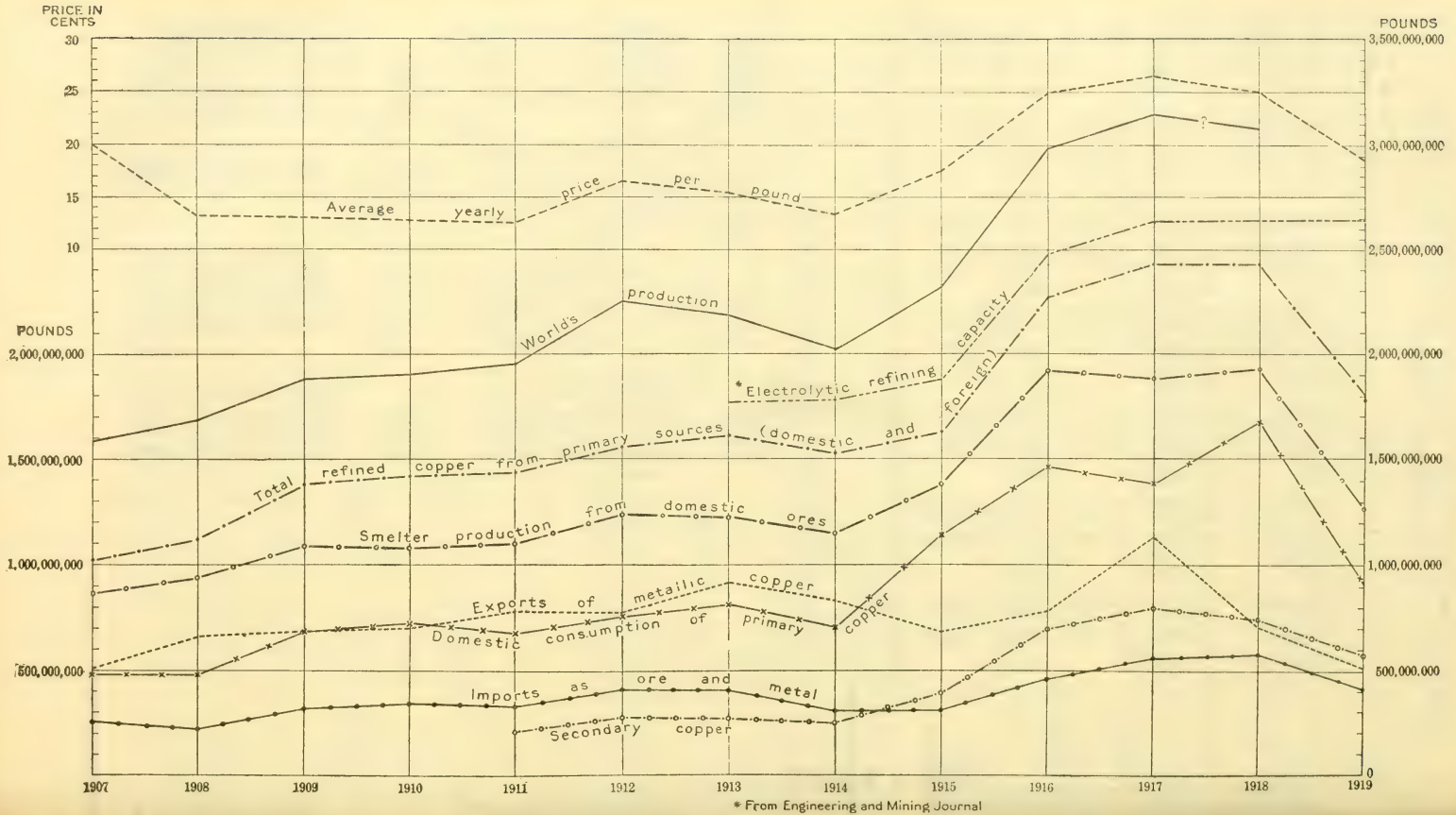


FIGURE 7.—Curves showing the principal features of the copper industry, 1907–1919.

World's production of copper (smelter output), 1908–1919, in pounds.[a]

[Compiled by Miss H. M. Meyer under direction of H. A. C. Jenison.]

Country.	1908	1909	1910	1911	1912	1913
Austria-Hungary	[b] 3,748,000	[b] 3,748,000	[b] 5,071,000	[b] 5,732,000	[b] 8,818,000	[b] 9,039,000
England	1,296,000	975,000	1,005,000	877,000	652,000	943,000
Germany	45,194,000	50,265,000	55,334,000	49,383,000	56,438,000	108,907,000
Italy	6,228,000	5,589,000	3,893,000	3,673,000	5,112,000	4,610,000
Norway	3,508,000	3,406,000	3,999,000	3,450,000	4,696,000	6,043,000
Portugal	[c] 17,637,000	[c] 17,637,000	[c] 15,432,000	[c] 16,535,000	[c] 14,330,000	[c] 12,787,000
Russia	37,771,000	39,244,000	50,014,000	57,201,000	74,895,000	74,283,000
Serbia	[b] 4,850,000	[b] 10,141,000	[b] 10,803,000	[b] 15,432,000	[b] 16,314,000	[b] 14,109,000
Spain	99,323,000	98,968,000	106,993,000	108,490,000	134,520,000	68,889,000
Sweden	6,191,000	5,236,000	6,859,000	7,101,000	8,724,000	9,292,000
Turkey	[b] 2,425,000	[b] 1,764,000	[b] 1,323,000	[b] 2,205,000	[b] 1,102,000	[b] 1,102,000
Total Europe	228,171,000	236,973,000	260,726,000	270,079,000	325,601,000	310,004,000
Canada	63,702,873	52,493,863	55,692,369	55,648,011	77,832,127	76,976,925
Cuba	[b] 6,614,000	[b] 6,614,000	[b] 7,716,000	[b] 8,377,000	[b] 9,700,000	[b] 7,495,000
Mexico	67,047,000	96,116,000	116,233,000	131,001,000	121,402,000	[c] 116,402,000
Newfoundland	[b] 3,307,000	[b] 3,087,000	[b] 2,425,000	[b] 2,646,000	[b] 1,102,000	.....
United States	942,570,721	1,092,951,624	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098
Total North America	1,083,241,000	1,251,262,000	1,262,226,000	1,294,905,000	1,453,305,000	1,425,358,000
Argentina	[b] 441,000	[b] 1,323,000	[b] 661,000	[b] 2,205,000	[b] 661,000	[b] 220,000
Bolivia	[d] 5,600,000	[d] 4,480,000	[d] 5,600,000	[d] 4,032,000	[d] 4,145,000	1,984,000
Chile	94,791,000	94,193,000	84,286,000	80,291,000	91,815,000	93,174,000
Peru	43,770,000	44,242,000	60,349,000	61,145,000	59,456,000	61,235,000
Venezuela	.....	.....	.....	[c] 1,609,000	[c] 1,874,000	[c] 1,587,000
Total South America	144,602,000	144,238,000	150,896,000	149,282,000	157,951,000	158,200,000
Belgian Kongo	.....	.....	.....	[c] 2,227,000	[c] 5,578,000	[c] 16,601,000
Namaqualand	[b] 5,291,000	[b] 5,070,000	[b] 5,512,000	[b] 5,512,000	[b] 5,512,000	[b] 5,512,000
Southern Rhodesia	187,000	194,000	86,000	.....	.....	.....
Union of South Africa	[c] 2,381,000	[c] 3,638,000	[c] 5,842,000	20,416,000	17,279,000	18,337,000
Total Africa	7,859,000	8,902,000	11,440,000	28,155,000	28,369,000	40,450,000
Japan	89,624,000	101,061,000	108,740,000	117,730,000	137,618,000	146,608,000
Australia	86,703,000	82,040,000	98,224,000	101,365,000	102,168,000	100,633,000
Grand total	1,640,200,000	1,824,476,000	1,892,252,000	1,961,516,000	2,205,012,000	2,181,253,000

[a] Where no footnotes are given, figures are taken from official publications. For countries from which ore or matte was exported for smelting, official figures have been converted to figures showing the quantity of copper recoverable by the smelters.

[b] Compiled by Henry Merton & Co. (Ltd.).

[c] Estimated by the United States Geological Survey.

[d] Figures taken from Chilean official publication.

World's production of copper (smelter output), 1908–1919, in pounds—Continued.

Country.	1914	1915	1916	1917	1918	1919
Austria-Hungary	[a] 7,275,000	.....	.....	.....	.....	[b]
England	763,000	527,000	623,000	419,000	401,000	323,000
Germany	101,853,000	129,852,000	[a] 77,161,000	[a] 99,208,000	[a] 88,184,000	[b]
Italy	4,054,000	2,072,000	4,116,000	2,934,000	2,511,000	3,029,000
Norway	6,305,000	6,235,000	3,558,000	3,990,000	[a] 4,850,000	[a] 970,000
Portugal	[a] 10,075,000	[a] 9,458,000	[a] 9,502,000	[a] 9,480,000	[a] 8,818,000	[a] 5,071,000
Russia	71,284,000	57,236,000	[a] 29,497,000	[a] 37,478,000	[b]	[b]
Spain	56,671,000	76,497,000	72,487,000	84,934,000	99,436,000	51,630,000
Sweden	10,344,000	10,055,000	7,013,000	9,751,000	6,517,000	7,844,000
Europe	268,624,000	291,932,000	203,957,000	248,194,000	[b]	[b]
Canada	75,735,960	100,785,150	117,150,028	109,227,332	118,769,434	75,054,000
Cuba	[a] 13,890,000	[a] 19,621,000	[a] 20,944,000	[a] 23,589,000	[a] 16,093,000	[a] 18,518,000
Mexico	[a] 80,116,000	45,410,000	62,634,000	112,404,000	154,813,000	84,150,000
United States	1,150,137,192	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595	1,286,419,329
North America	1,319,879,000	1,553,826,000	2,128,579,000	2,131,341,000	2,198,209,000	1,464,141,000
Argentina	[a] 661,000	[a] 661,000	[a] 661,000	[a] 661,000	[a] 661,000	.....
Bolivia	4,188,000	11,464,000	14,110,000	16,754,000	[c] 13,450,000	[b]
Chile	98,469,000	115,392,000	157,161,000	226,032,000	[a] 253,529,000	[a] 145,000,000
Peru	59,723,000	76,561,000	94,970,000	99,595,000	97,915,000	86,486,000
Venezuela	[a] 1,587,000	[a] 1,653,000	[a] 1,852,000	[a] 1,896,000	[a] 3,616,000	[b]
South America	164,628,000	205,731,000	268,754,000	344,938,000	369,171,000	[b]
Belgian Kongo	[a] 24,007,000	[a] 31,482,000	[a] 49,604,000	[a] 61,509,000	[a] 45,327,000	[a] 51,588,000
Namaqualand	[a] 5,512,000	.....	.....	.....	.....	.....
Southern Rhodesia	2,022,000	7,035,000	7,041,000	7,822,000	6,508,000	6,022,000
Union of South Africa	25,342,000	24,235,000	23,256,000	17,859,000	10,635,000	6,008,000
Africa	56,883,000	62,752,000	79,901,000	87,190,000	62,470,000	63,618,000
Japan	155,343,000	166,262,000	221,862,000	238,181,000	199,168,000	172,937,000
Australia	88,733,000	96,872,000	88,993,000	87,875,000	86,674,000	42,564,000
Grand total	2,054,090,000	2,377,375,000	2,992,046,000	3,137,719,000	[b]	[b]

[a] Estimated by the United States Geological Survey.
[b] Figures not yet available.
[c] Incomplete.

World's production of copper (smelter output), 1908–1919, in metric tons.[a]

[Compiled by Miss H. M. Meyer under direction of H. A. C. Jenison.]

Country.	1908	1909	1910	1911	1912	1913
Austria-Hungary	[b] 1,700	[b] 1,700	[b] 2,300	[b] 2,600	[b] 4,000	[b] 4,100
England	588	442	456	398	296	428
Germany	20,500	22,800	25,100	22,400	25,600	49,400
Italy	2,825	2,535	1,766	1,666	2,319	2,091
Norway	1,591	1,545	1,814	1,565	2,130	2,741
Portugal	[c] 8,000	[c] 8,000	[c] 7,000	[c] 7,500	[c] 6,500	[c] 5,800
Russia	17,133	17,801	22,686	25,946	33,972	33,694
Serbia	[b] 2,200	[b] 4,600	[b] 4,900	[b] 7,000	[b] 7,400	[b] 6,400
Spain	45,053	44,892	48,532	49,211	61,018	31,248
Sweden	2,808	2,375	3,111	3,221	3,957	4,215
Turkey	[b] 1,100	[b] 800	[b] 600	[b] 1,000	[b] 500	[b] 500
Total Europe	103,498	107,490	118,265	122,507	147,692	140,617
Canada	28,895	23,811	25,262	25,242	35,304	34,916
Cuba	[b] 3,000	[b] 3,000	[b] 3,500	[b] 3,800	[b] 4,400	[b] 3,400
Mexico	30,413	43,598	52,723	59,421	55,068	[c] 52,800
Newfoundland	[b] 1,500	[b] 1,400	[b] 1,100	[b] 1,200	[b] 500	.....
United States	427,547	495,760	489,957	497,702	563,943	555,422
Total North America	491,355	567,569	572,542	587,365	659,215	646,538
Argentina	[b] 200	[b] 600	[b] 300	[b] 1,000	[b] 300	[b] 100
Bolivia	[d] 2,540	[d] 2,032	[d] 2,540	[d] 1,829	[d] 1,880	900
Chile	42,997	42,726	38,232	36,420	41,647	42,263
Peru	19,854	20,068	27,374	27,735	26,969	27,776
Venezuela	.....	.....	.....	[c] 730	[c] 850	[c] 720
Total South America	65,591	65,426	68,446	67,714	71,646	71,759
Belgian Kongo	.....	.....	.....	[c] 1,010	[c] 2,530	[c] 7,530
Namaqualand	[b] 2,400	[b] 2,300	[b] 2,500	[b] 2,500	[b] 2,500	[b] 2,500
Southern Rhodesia	85	88	39	.....	.....	.....
Union of South Africa	[c] 1,080	[c] 1,650	[c] 2,650	9,261	7,838	8,318
Total Africa	3,565	4,038	5,189	12,771	12,868	18,348
Japan	40,653	45,841	49,324	53,402	62,423	66,501
Australia	39,328	37,213	44,554	45,979	46,343	45,647
Grand total	743,990	827,577	858,320	889,738	1,000,187	989,410

[a] Where no footnotes are given, figures are taken from official publications. For countries from which ore or matte was exported for smelting, official figures have been converted to figures showing the quantity of copper recoverable by the smelters.

[b] Compiled by Henry Merton & Co. (Ltd.).

[c] Estimated by the United States Geological Survey.

[d] Figures taken from Chilean official publication.

World's production of copper (smelter output), 1908–1919, in metric tons—Continued.

Country.	1914	1915	1916	1917	1918	1919
Austria-Hungary	a 3,300					(b)
England	346	239	282	190	182	146
Germany	46,200	58,900	a 35,000	a 45,000	a 40,000	(b)
Italy	1,839	940	1,867	1,331	1,139	1,374
Norway	2,860	2,828	1,614	1,810	a 2,200	a 440
Portugal	a 4,570	a 4,290	a 4,310	a 4,300	a 4,000	a 2,300
Russia	32,334	25,962	a 13,380	a 17,000	(b)	(b)
Spain	25,706	34,699	32,880	38,526	45,104	23,419
Sweden	4,692	4,561	3,181	4,423	2,956	3,558
Europe	121,847	132,419	92,514	112,580	(b)	(b)
Canada	34,354	45,716	53,139	49,545	53,873	34,044
Cuba	a 6,300	a 8,900	a 9,500	a 10,700	a 7,300	a 8,400
Mexico	a 36,340	20,598	28,411	50,986	70,223	38,170
United States	521,699	629,597	874,467	855,539	865,705	583,516
North America	598,693	704,811	965,517	966,770	997,101	664,130
Argentina	a 300	a 300	a 300	a 300	a 300	
Bolivia	1,900	5,200	6,400	7,600	c 6,100	(b)
Chile	44,665	52,341	71,288	102,527	a 115,000	a 65,800
Peru	27,090	34,728	43,078	45,176	44,414	39,230
Venezuela	a 720	a 750	a 840	a 860	a 1,640	(b)
South America	74,675	93,319	121,906	156,463	167,454	(b)
Belgian Kongo	a 10,890	a 14,280	a 22,500	a 27,900	a 20,560	a 23,400
Namaqualand	a 2,500					
Southern Rhodesia	917	3,191	3,194	3,548	2,952	2,732
Union of South Africa	11,495	10,993	10,549	8,101	4,824	2,725
Africa	25,802	28,464	36,243	39,549	28,336	28,857
Japan	70,463	75,416	100,636	108,038	90,341	78,443
Australia	40,249	43,941	40,367	39,860	39,315	19,307
Grand total	931,729	1,078,370	1,357,183	1,423,260	(b)	(b)

a Estimated by the United States Geological Survey. b Figures not yet available. c Incomplete.

GENERAL CONDITION OF THE INDUSTRY.

The salient features of the copper industry for the year 1919 were the continued shortage and inefficiency of labor, the reaction from the war as reflected in a poor and very unsettled market, and the difficulties of railway transportation. Smelter production decreased 32.6 per cent and refinery production decreased 25.8 per cent. Domestic consumption declined 44.97 per cent and the stocks of raw and refined copper reached a figure greater than ever before in the history of the industry.

Of the adverse conditions affecting the industry the principal one was the poor and unsettled market. Production was being maintained at the maximum rate possible under the wretched labor situation when the war demand for copper was suddenly terminated. The collapse of war demands upon all industries came considerably before it was expected and consequently little provision had been made for the return to peace conditions. In any event the future was so uncertain that little or nothing could be done to protect many industries from the reaction from the war, until the new peace-time tendencies were apparent. This condition was particularly true in the copper industry, in which the momentum of its great war-time effort carried production at a high rate for some time after the reaction set in, and a large accumulation of stocks resulted. Fluctuating prices, the uncertain future, and the great quantity of copper in stock made most consumers of copper unwilling to buy more than was absolutely necessary, and very little copper was

required by industrial expansion, normally the great factor in consumption. No sooner had the price of copper recovered sufficiently to enable the producer to cope with some of the domestic problems than the collapse of foreign demand further increased his difficulties. The reluctance of foreign buyers to buy American copper at the falling rate of exchange soon became inability. Furthermore the social and industrial conditions in Europe were unfavorable to increased industrial activity, and the new political questions that were constantly arising made cautious investment advisable. As a result the actual demand for copper in Europe was confined almost entirely to the essential replacement needs and the quantity of old and scrap copper available in many of the belligerent countries was sufficient to meet most of these needs. The foreign demand for American copper therefore fell far below normal.

These conditions forced the American mines and smelters to decrease their production. Some were shut down entirely; others operated at the minimum capacity that would keep the organization intact and the equipment in proper order. These operations were often conducted at a loss, the operators believing that smaller losses would be incurred by continuing production than by shutting down entirely and later undergoing the great expense of reopening the mines.

The conditions were not, however, entirely without compensation. During the stress of war exploration and development work was greatly neglected in favor of production, and many mines had almost exhausted their developed reserves when the end of the war came. The removal of the great demand for copper permitted these mines for the first time in several years to undertake the exploratory and development work so essential to future production. Activity of this nature characterized practically all the copper districts, and in many mines it was the only work undertaken.

During 1919 and 1920 development work has been very expensive, but such work is absolutely essential if the mines are to take full advantage of a good market when normal conditions return. Conditions were such that no reduction in cost could be effected during 1919, and 1920 has shown a still further increase in expense. Such conditions are probably temporary, but they must be slow in readjustment, and until there is an abundance of labor little can be hoped for in reduction of costs. In 1920 some improvement has been shown in the labor situation, which if continued will be of material advantage to the copper industry, both in cost of production and in bettering the market; but the return of the industry to what may be considered a normal basis will not be effected in a few months. No industry that is international in its scope and activity and that is dependent upon industrial activity or great military need for its prosperity can experience such prosperity until the greater part of the industrial world has solved its problems and restored normal conditions of trade, finance, and expansion. The immediate outlook is consequently not bright. Factories are idle; money or labor or both are not obtainable for a general electrification of railways, for construction of hydroelectric plants, or for employment in factories. The labor situation in Europe is such that any program of industrial expansion is considerably if not indefinitely postponed, and, with the exception of a few favored industries and localities, the same condition very largely prevails in

the United States. Furthermore, general prosperity in America alone can not restore the American copper industry to the prominent place it occupied before the World War. A European market for its exportable surplus is indispensable, and such a market is dependent upon a great improvement in Europe's industrial and financial situation.

The small uncertain demand for copper that accompanied the restoration of peace and the great quantities available soon forced the price down from about 24.7 cents to about 15 cents a pound. This price was considerably below the cost of production of a very large part of the output in 1918, but much of the copper in stock could not be held to advantage even at so low a price. The continued appearance of such copper upon the market kept the price down when it first showed any tendency to rise. These conditions continued through the first part of 1919, and the price showed little or no real improvement until most of the copper that could not be held had disappeared from the market. The price fluctuated throughout the year and attained an average of only 18.6 cents, or at least 25 per cent less than the average price for any other year since 1915, though the cost of labor and supplies had risen as much as 150 per cent during that same period. In some places the cost of labor alone is reported to have risen as much as 100 per cent and the efficiency to have decreased 50 per cent since 1915.

PRODUCTION.

SMELTER PRODUCTION.

Copper produced in the United States from 1845 to 1919, inclusive.

[Values rounded.]

Year.	Quantity.	Increase.	Value.	Year.	Quantity.	Increase.	Value.
	Pounds.	*Pounds.*			*Pounds.*	*Pounds.*	
1845	224,000	.....	$45,000	1884	144,946,653	29,420,600	$18,843,000
1846	336,000	112,000	57,000	1885	165,875,483	20,928,830	17,915,000
1847	672,000	336,000	124,000	1886	157,763,043	[a] 8,112,440	17,512,000
1848	1,120,000	448,000	218,000	1887	181,477,331	23,714,288	25,044,000
1849	1,568,000	448,000	349,000	1888	226,361,466	45,440,942	38,029,000
1850	1,456,000	[a] 112,000	320,000	1889	226,775,962	414,496	30,615,000
1851	2,016,000	560,000	334,000	1890	259,763,092	32,987,130	40,523,000
1852	2,464,000	448,000	542,000	1891	284,121,764	24,358,672	36,368,000
1853	4,480,000	2,016,000	985,000	1892	344,998,679	60,876,915	40,020,000
1854	5,040,000	560,000	1,108,000	1893	329,354,398	[a] 15,644,281	35,570,000
1855	6,720,000	1,680,000	1,814,000	1894	354,188,374	24,833,976	33,648,000
1856	8,960,000	2,240,000	2,419,000	1895	380,613,404	26,425,030	40,726,000
1857	10,752,000	1,792,000	2,688,000	1896	460,061,430	79,448,026	49,687,000
1858	12,320,000	1,568,000	2,833,000	1897	494,078,274	34,016,844	59,289,000
1859	14,112,000	1,792,000	3,104,000	1898	526,512,987	32,434,713	65,288,000
1860	16,128,000	2,016,000	3,709,000	1899	568,666,921	42,153,934	97,242,000
1861	16,800,000	672,000	3,696,000	1900	606,117,166	37,450,245	100,615,000
1862	21,160,000	4,360,000	4,655,000	1901	602,072,519	[a] 4,044,647	100,546,000
1863	19,040,000	[a] 2,120,000	6,473,000	1902	659,508,644	57,436,125	80,460,000
1864	17,920,000	[a] 1,120,000	8,422,000	1903	698,044,517	38,535,873	95,632,000
1865	19,040,000	1,120,000	7,473,000	1904	812,537,267	114,492,750	104,005,000
1866	19,936,000	896,000	6,828,000	1905	888,784,267	76,247,000	138,650,000
1867	22,400,000	2,464,000	5,682,000	1906	917,805,682	29,021,415	177,136,000
1868	25,984,000	3,584,000	5,976,000	1907	868,996,491	[a] 48,809,191	173,799,000
1869	28,000,000	2,016,000	6,790,000	1908	942,570,721	73,574,230	124,419,000
1870	28,224,000	224,000	5,977,000	1909	1,092,951,624	150,380,903	142,084,000
1871	29,120,000	896,000	7,023,000	1910	1,080,159,509	[a] 12,792,115	137,180,000
1872	28,000,000	[a] 1,120,000	9,956,000	1911	1,097,232,749	17,073,240	137,154,000
1873	34,720,000	6,720,000	9,721,000	1912	1,243,268,720	146,035,971	205,139,000
1874	39,200,000	4,480,000	8,624,000	1913	1,224,484,098	[a] 18,784,622	189,795,000
1875	40,320,000	1,120,000	9,152,000	1914	1,150,137,192	[a] 74,346,906	152,968,000
1876	42,560,000	2,240,000	8,937,000	1915	1,388,009,527	237,872,335	242,902,000
1877	47,040,000	4,480,000	8,937,000	1916	1,927,850,548	539,841,021	474,288,000
1878	48,160,000	1,120,000	7,994,000	1917	1,886,120,721	[a] 41,729,827	514,911,000
1879	51,520,000	3,360,000	9,582,000	1918	1,908,533,595	22,412,874	471,408,000
1880	60,480,000	8,960,000	12,943,000	1919	1,286,419,329	[a] 622,114,266	239,274,000
1881	71,680,000	11,200,000	13,046,000				
1882	90,646,232	18,966,232	17,313,000		28,393,008,432	.....	4,873,595,000
1883	115,526,053	24,879,821	19,062,000				

[a] Decrease.

The figures in this table, except those for 1919, are taken from the volumes of Mineral Resources of the United States. Statistics from 1882 to 1919, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the Survey from the best sources available. Reliable figures for years prior to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and since 1880, when Arizona and Montana became large producers, a very rapid growth.

The figures of smelter production in 1919 are based on returns made confidentially to the United States Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries concerning distribution of the output sincere thanks are extended. The following list gives the name of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1919. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper reduction plants that treated materials from the United States in 1919.

Location.	Company.	Final copper product.
Arizona:		
Ajo	New Cornelia Copper Co.	Electrolytic.
Clarkdale	United Verde Copper Co.	Blister.
Do.	United Verde Extension Mining Co.	Do.
Clifton	Arizona Copper Co. (Ltd.)	Do.
Douglas	Calumet & Arizona Mining Co.	Do.
Do.	Phelps Dodge Corporation	Do.
Globe	Old Dominion Co.	Do.
Hayden	American Smelting & Refining Co.	Do.
Humboldt	Consolidated Arizona Smelting Co.	Do.
Miami	International Smelting Co.	Do.
Morenci	Phelps Dodge Corporation	Do.
Sasco	American Smelting & Refining Co.	Do.
California:		
Campo Seco	Penn Mining Co.	Do.
Kennett	United States Smelting, Refining & Mining Co.	Do.
Martinez	Mountain Copper Co. (Ltd.)	Do.
Colorado:		
Salida	Ohio & Colorado Smelting & Refining Co.	Matte.
Maryland:		
Baltimore	Baltimore Copper Smelting & Rolling Co.	Electrolytic.
Michigan:		
Hancock	Lake Superior Smelting Co.	Anodes and lake.
Do.	Quincy Mining Co.	Do.
Houghton	Michigan Smelting Co.	Do.
Hubbell	Calumet & Hecla Mining Co.	Do.
Montana:		
Anaconda	Anaconda Copper Mining Co.	Blister.
Butte	East Butte Copper Mining Co.	Do.
Great Falls	Anaconda Copper Mining Co.	Blister and electrolytic.
Nebraska:		
Omaha	American Smelting & Refining Co.	Blister.
Nevada:		
McGill	Nevada Consolidated Copper Co.	Do.
Thompson	Mason Valley Mines Co.	Do.
New Jersey: [a]		
Chrome	United States Metals Refining Co.	Blister and electrolytic.
Maurer	American Smelting & Refining Co.	Do.
Newark	Balbach Smelting & Refining Co.	Electrolytic and casting.
Perth Amboy	Raritan Copper Works	Do.

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.

Copper reduction plants that treated material from the United States in 1919—Contd.

Location.	Company.	Final copper product.
New York:		
Laurel Hill	Nichols Copper Co	Blister, electrolytic, and casting.
Tennessee:		
Copperhill	Tennessee Copper Co	Blister.
Isabella	Ducktown Sulphur, Copper & Iron Co. (Ltd.)	Matte.
Texas:		
El Paso	American Smelting & Refining Co	Blister.
Utah:		
Garfield	Garfield Smelting Co	Do.
International	International Smelting Co	Do.
Virginia:		
West Norfolk	Norfolk Smelting Co	Do.
Washington:		
Tacoma	American Smelting & Refining Co	Blister and electrolytic.
British Columbia:		
Anyox	Granby Consolidated Mining, Smelting & Power Co.	Blister.
Grand Forks	do	Do.
Trail	Consolidated Mining & Smelting Co. of Canada	Blister and electrolytic.

During the year 42 copper smelting and refining plants treated material from the United States; of these, 39 were domestic plants and 3 were foreign.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. As to blister copper, the figures represent the fine copper content. Some casting and electrolytic copper is produced direct from ore or matte, and this is included in the smelter production.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1919. These mines reported 1,212,334,041 pounds of copper.

The mines and smelters of several of the large copper producers are under the same management, and their production is reported on the same basis. The figures furnished by mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion are likely to show considerable discrepancy from the smelter returns, as the mines may report a considerable quantity that has not reached the stage of blister copper by the end of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters in the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or the end of the year, so that there is not the balance of overlap that occurs if the industry is in normal condition throughout the year. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for and consequently is not always reported by the mines.

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

Copper produced from domestic ores as reported by mines, smelters, and refineries, 1906–1919, in pounds.

Year.	Mine.	Smelter.	Refinery.
1906	916,971,387	917,805,682	897,382,387
1907	847,151,015	868,996,491	826,622,390
1908	956,840,578	942,570,721	919,111,414
1909	1,126,521,126	1,092,951,624	1,065,564,921
1910	1,088,237,432	1,080,159,509	1,071,894,876
1911	1,114,764,197	1,097,232,749	1,101,270,803
1912	1,249,094,891	1,243,268,720	1,203,676,895
1913	1,235,569,727	1,224,484,098	1,236,823,913
1914	1,148,431,437	1,150,137,192	1,210,423,189
1915	1,488,071,528	1,388,009,527	1,387,705,523
1916	2,005,875,312	1,927,850,548	1,888,752,199
1917	1,895,434,349	1,886,120,721	1,873,546,171
1918	1,910,022,841	1,908,533,595	1,882,874,191
1919	1,212,334,041	1,286,419,329	1,433,485,795

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last 14 years has been nearly balanced by copper recovered from lead, zinc, gold, silver, and sulphur ores, which carry so little copper that it is not paid for and consequently has not usually been reported by the mines.

PRODUCTION BY STATES.

Twenty-two States and Territories contributed to the smelter production of copper in 1919. The subjoined table shows the mine and the smelter output of individual States for 1918 and 1919.

Copper produced in the United States in 1918 and 1919, according to smelter and mine returns, by States, in pounds.

State.	1918		1919			
			Smelter returns.			Mine returns.
	Smelter returns.	Mine returns.	Rank.	Percentage of total.	Quantity.	
Alaska	67,081,648	69,224,951	7	4.39	56,534,992	47,220,771
Arizona	769,521,729	764,855,874	1	41.71	536,515,368	538,100,844
California	44,150,761	47,674,660	8	1.83	23,548,698	21,732,507
Colorado	7,591,570	6,277,332	10	.38	4,892,558	3,560,207
Georgia	397,078	397,078	18	.....	8,306	8,306
Idaho	5,836,795	6,533,888	11	.31	3,966,655	3,122,763
Maine	501,169	766,000	16	.03	376,186	376,186
Michigan	231,096,158	226,794,139	2	13.81	177,594,135	178,826,486
Missouri	232,073	577,665	14	.05	588,570	1,617,200
Montana	326,426,761	323,174,850	3	13.70	176,289,873	169,981,288
Nevada	106,266,603	116,316,441	5	5.03	64,683,734	52,331,175
New Mexico	96,559,580	98,264,563	6	4.69	60,377,320	51,150,541
North Carolina	79,200	.....	19	.....	3,334	3,334
Oregon	2,630,499	2,451,016	12	.22	2,808,017	2,214,815
Pennsylvania, Maryland, and Virginia	[a] 35,748	[b] 779,393	.....	.....	.....	.....
South Carolina	.....	.....	20	.....	2,297	2,299
South Dakota	.....	64,806	.....	.....	(c)	.....
Tennessee	15,053,568	14,799,680	9	1.21	15,629,454	15,623,589
Texas	13,851	9,308	21	.....	2,153	979
Utah	230,964,908	227,169,630	4	11.18	143,836,304	124,061,807
Vermont	896,630	1,116,384	15	.05	582,561	582,468
Washington	2,330,568	1,922,406	13	.20	2,552,134	1,676,576
Wyoming	866,698	852,777	17	.01	150,051	139,900
Undistributed	.....	.....	.....	1.20	15,476,629	.....
	1,908,533,595	1,910,022,841	.....	100.00	1,286,419,329	1,212,334,041

[a] Pennsylvania and Virginia. No smelter output for Maryland in 1918.
[b] Pennsylvania alone. No production for mines of Maryland and Virginia in 1918.
[c] Included under "Undistributed."

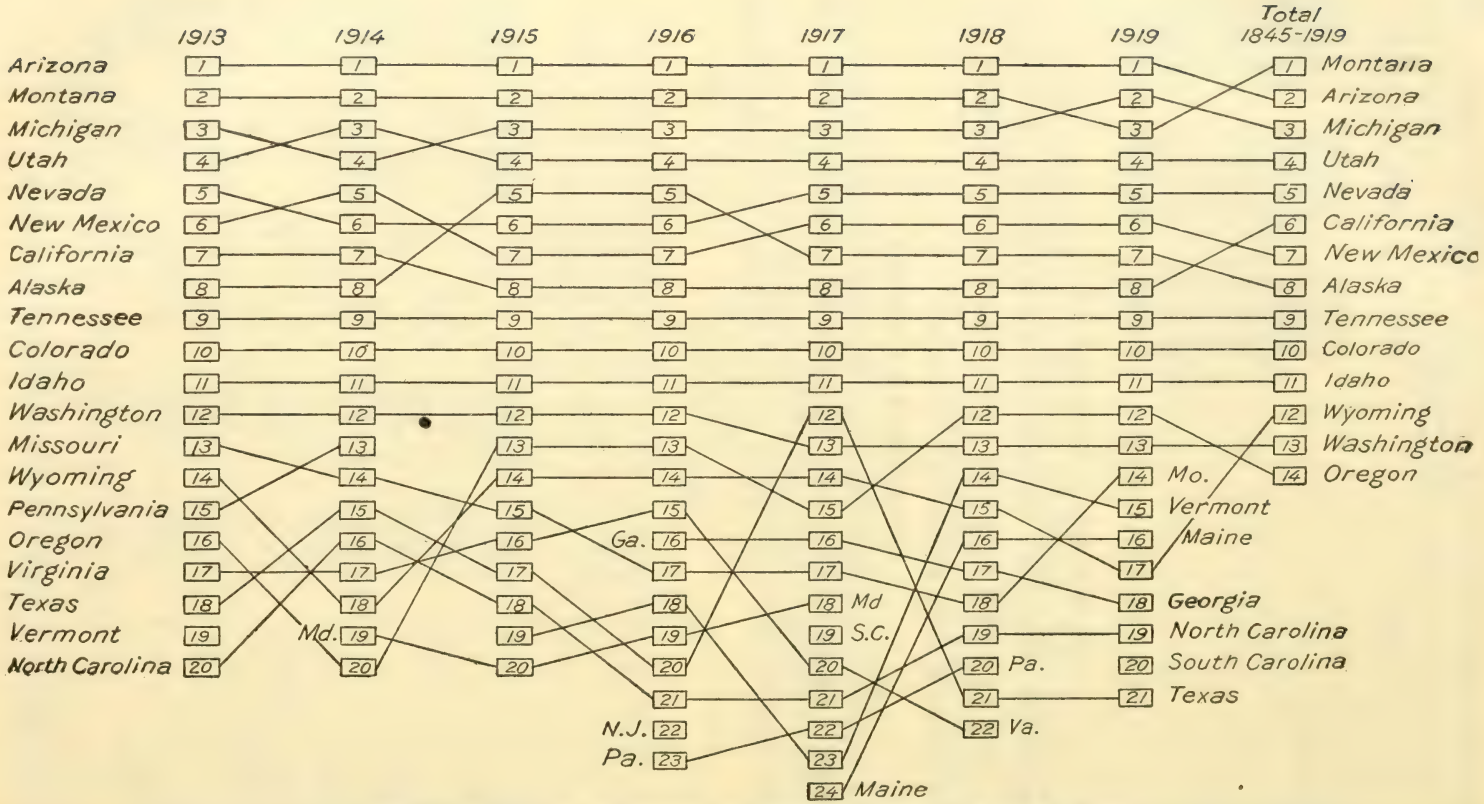


FIGURE 8.—Chart showing rank of States producing copper. Prepared by Helena M. Meyer.

According to smelter returns, the four leading States—Arizona, Michigan, Montana, and Utah—produced 80 per cent of the total output of 1919, as compared with 82 per cent in 1918; and the eight leading States, including Nevada, New Mexico, Alaska, and California produced 96.34 per cent of the total output in 1919.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced. Likewise, the distribution of copper derived from zinc residues is subject to some error.

The following table shows the production from 1910 to 1919. The report for 1915 contains a table showing the production of copper by the different States from 1845.

Copper produced in the United States, 1910–1919, by States, in pounds.

[Smelter output.]

State.	1910	1911	1912	1913	1914
Alaska	4,311,026	22,314,889	31,926,209	23,423,070	24,985,847
Arizona	297,250,538	303,202,532	359,322,096	404,278,809	382,449,922
California	45,760,200	35,835,651	31,516,471	32,492,265	29,784,173
Colorado	9,307,497	9,791,861	7,963,520	9,052,104	7,316,066
Idaho	6,877,515	4,514,116	7,182,185	8,711,490	5,875,205
Michigan	221,462,984	218,185,236	231,112,228	155,715,286	158,009,748
Montana	283,078,516	271,816,098	308,794,483	285,724,467	236,805,845
Nevada	64,494,640	65,561,015	83,413,900	85,209,536	60,122,904
New Mexico	3,784,609	2,860,400	29,170,400	50,196,881	64,204,703
Oregon	22,022	125,943	311,860	77,812	5,599
Utah	125,185,455	142,340,215	132,150,052	148,057,450	160,589,660
Washington	65,021	195,503	1,069,938	732,742	683,602
Wyoming	217,127	130,499	25,080	362,235	17,082
Other States and unapportioned	18,342,359	20,358,791	19,310,298	20,449,951	19,286,836
	1,080,159,509	1,097,232,749	1,243,268,720	1,224,484,098	1,150,137,192

State.	1915	1916	1917	1918	1919
Alaska	70,695,286	113,823,064	84,759,086	67,081,648	56,534,992
Arizona	432,467,690	694,847,307	719,035,514	769,521,729	536,515,368
California	37,658,444	43,400,876	44,933,846	44,150,761	23,548,698
Colorado	7,272,178	9,536,193	10,054,951	7,591,570	4,892,558
Idaho	6,217,728	7,248,794	6,446,224	5,836,795	3,966,655
Michigan	238,956,410	269,794,531	268,508,091	231,096,158	177,594,135
Montana	268,263,040	352,139,768	276,225,977	326,426,761	176,289,873
Nevada	67,757,322	100,816,724	115,028,161	106,266,603	64,683,734
New Mexico	62,817,234	79,863,439	107,593,615	96,559,580	60,377,320
Oregon	797,471	2,433,567	1,105,097	2,630,499	2,808,017
Utah	175,177,695	232,335,950	227,840,447	230,964,908	143,836,304
Washington	903,661	2,473,481	2,051,416	2,330,568	2,552,134
Wyoming	351,871	1,784,351	2,019,767	866,698	150,051
Other States and unapportioned	18,673,497	17,352,503	20,518,529	17,209,317	32,669,490
	1,388,009,527	1,927,850,548	1,886,120,721	1,908,533,595	1,286,419,329

Copper produced in the United States, 1845–1919, by States.

State.	Quantity (pounds).	Percentage.	Rank.
Alaska	532,355,546	1.87	8
Arizona	7,792,771,546	27.45	2
California	768,456,142	2.71	6
Colorado	279,729,972	.99	9
Idaho	110,556,876	.39	10
Michigan	6,706,976,151	23.62	3
Montana	7,834,179,518	27.59	1
Nevada	886,798,996	3.12	5
New Mexico	645,966,735	2.28	7
Oregon	12,745,649	.04	13
Utah	2,252,373,254	7.93	4
Washington	14,970,826	.05	12
Wyoming	31,551,034	.11	11
Other States and unapportioned	523,576,187	1.85	.....
	28,393,008,432	100.00	.....

The figures in the first column of the preceding table show the copper output of each important copper-producing State since the beginning of the industry. Some copper was produced in New Mexico in the early years of the last century, but the exact quantity is not known, though it was not large as measured by the present production of the metal. Prior to 1845, also, a little copper was produced in Michigan and a considerable quantity in the Eastern States.

Under "Other States and unapportioned" is included some copper assigned to "lead desilverizers" in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that about 367,000,000 pounds has been derived from Tennessee. To the remainder Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all the Appalachian States.

Montana, Arizona, and Michigan stand out as the three chief copper-producing States. Montana ranks first, with nearly 28 per cent of the entire output of the country; Arizona ranks second, with more than 27 per cent; and Michigan ranks third, with nearly 24 per cent. The three leading States have produced 79 per cent of the total. Utah, ranking next in order, has produced about 8 per cent of the total output.

Fourteen districts in eight States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Five of these districts are in Arizona, 2 each in California and Utah, and 1 each in Montana, Michigan, Nevada, New Mexico, and Tennessee. Two districts stand out prominently. They are the Butte district, Montana, which has produced 27.44 per cent of the output of the country, and the Lake Superior district, Michigan, which has produced 23.57 per cent of the total output. Bisbee, ranking third, has yielded 9.40 per cent of the total. The 14 districts have yielded 93 per cent of the total output of the United States since 1845. (See table at bottom of p. 553.)

Mine production of copper in the principal districts in 1919.

District or region.	State.	Mine output (pounds).	Percentage of total production.	Rank.
Lake Superior	Michigan	178,826,000	14.75	1
Globe-Miami	Arizona	171,106,000	14.11	2
Butte	Montana	169,051,000	13.94	3
Bisbee (Warren)	Arizona	122,311,000	10.09	4
Bingham	Utah	116,697,000	9.63	5
Jerome	Arizona	72,333,000	5.97	6
Ray (Mineral Creek)	do	53,001,000	4.37	7
Ely (Robinson)	Nevada	47,871,000	3.95	8
Morenci-Metcalf	Arizona	44,868,000	3.70	9
Santa Rita (Central)	New Mexico	40,359,000	3.33	10
Ajo	Arizona	39,879,000	3.29	11
Copper River	Alaska	36,291,000	2.99	12
Ducktown	Tennessee	15,624,000	1.29	13
Plumas County	California	10,860,000	.90	14
Pioneer	Arizona	10,549,000	.87	15
Prince William Sound	Alaska	10,300,000	.85	16
Shasta County	California	7,626,000	.63	17
Burro Mountain	New Mexico	6,101,000	.50	18
Big Bug	Arizona	5,716,000	.47	19
Banner	do	5,420,000	.45	20
Lordsburg	New Mexico	3,516,000	.29	21
Tintic	Utah	3,251,000	.27	22
Yerington	Nevada	3,077,000	.25	23
Courtland (Turquoise)	Arizona	2,549,000	.21	24
Silver Bell	do	2,490,000	.21	25
Baker County	Oregon	2,095,000	.17	26
Foothill Belt	California	2,048,000	.17	27
San Juan-Ouray-San Miguel counties	Colorado	1,688,000	.14	28
Coeur d'Alene region	Idaho	1,475,000	.12	29
Cochise	Arizona	1,332,000	.11	30
Alder Creek	Idaho	1,322,000	.11	31
Ophir	Utah	1,290,000	.11	32
Peck	Arizona	1,131,000	.09	33
Pima	do	1,005,000	.08	34

As shown in this table, 34 districts in 1919 each produced 1,000,000 pounds or more of copper.

In the following table the statistics for the later years are compiled from reports furnished to the United States Geological Survey by the producing companies and those for the earlier years are taken mainly from reports on the several districts by members of the Survey.

Blister copper produced in the principal districts to the end of 1919.

District.	State.	Date production began.	Quantity (pounds).	Percentage of total production.	Rank.
Butte	Montana	1868	7,790,651,000	27.44	1
Lake Superior	Michigan	1845	6,691,108,000	23.57	2
Bisbee	Arizona	1880	2,669,922,000	9.40	3
Bingham	Utah	1896	1,926,410,000	6.78	4
Morenci-Metcalf	Arizona	1873	1,466,931,000	5.17	5
Globe-Miami	do	1881	1,445,602,000	5.09	6
Jerome	do	1883	1,207,453,000	4.25	7
Ely (Robinson)	Nevada	1908	768,035,000	2.71	8
Shasta County	California	1897	573,305,000	2.02	9
Santa Rita (Central)	New Mexico	1800	573,245,000	2.02	10
Ray (Mineral Creek)	Arizona	1911	527,805,000	1.86	11
Ducktown	Tennessee	1850	366,741,000	1.29	12
Foothill belt	California	1862	152,844,000	.54	13
Tintic	Utah	1880	149,776,000	.53	14

QUANTITY AND YIELD OF COPPER-BEARING ORES.

The following tables show the quantity and the yield in copper of the ore produced by the mines of the United States in 1919. The figures are taken from the mines reports which form parts of the annual volume Mineral Resources. The close agreement between the output as reported by the mines and the actual recovery of metal as reported by the smelters indicates that the tenor of the ores as reported by the mines is very close to the actual recovery. The classification of some of the complex western ores is difficult and more or less arbitrary. Under copper ores are classed those which contain 2.5 per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper.

Under copper-lead and copper-zinc ores are classed complex ores in which copper is a valuable constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for their content of other metals. No attempt has been made to compile tables showing the quantity and yield of this group of copper-bearing ores, but together with old slags and other materials they have yielded a total of 20,526,472 pounds of copper.

Copper produced in the United States in 1919 from ores in which copper constitutes the principal value.

State.	Copper ore.	Copper in ore.		Gold in ore.	Silver in ore.	Value in gold and silver per ton.
		Quantity.	Percentage.			
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	492,644	45,058,171	4.57	3,086.08	488,034	$1.24
Arizona	13,347,182	537,201,237	2.01	78,103.32	3,711,052	.43
California	486,433	21,592,163	2.22	6,137.17	349,480	1.07
Colorado	9,417	774,435	4.11	4,992.49	104,381	23.37
Georgia	350	8,306	1.19	.....	.....	.....
Idaho	51,546	2,545,044	2.47	962.13	246,983	5.75
Maine	12,000	376,186	1.57	17.01	4,142	.42
Michigan	7,690,253	178,826,486	1.16	.....	441,430	.27
Montana	3,081,451	165,321,847	2.68	16,612.99	6,341,825	2.42
Nevada	2,363,189	52,042,089	1.10	16,254.92	73,371	.18
New Mexico	2,027,107	50,998,068	1.26	11,295.02	238,271	.25
North Carolina	17	3,334	9.81	.97	19	2.41
Oregon	28,220	2,214,461	3.92	9,926.46	18,153	7.99
South Carolina	16	2,299	7.18	1.11	17	2.63
Tennessee	555,018	15,623,589	1.41	273.90	98,288	.21
Texas	16	979	3.06	.....	25	1.75
Utah	5,884,118	116,312,084	.99	38,873.70	586,417	.25
Vermont	23,400	582,468	1.24	18.24	2,214	.12
Washington	68,447	1,669,060	1.22	153.01	146,891	2.45
Wyoming	798	139,900	8.77	2.32	150	.27
Total and average.	36,121,622	1,191,292,206	1.65	186,710.84	12,851,143	.51

Copper ores concentrated, smelted, and leached and copper produced from each class of ore in the United States in 1919.

State.	Ore concentrated.			
	Quantity.	Concentrates produced.	Copper in concentrates.	Percentage of copper.
	Short tons.	*Short tons.*	*Pounds.*	
Alaska	451,445	52,949	34,835,920	3.86
Arizona	9,540,048	631,437	256,754,547	1.35
California	388,583	26,257	12,747,478	1.64
Idaho	34,684	2,444	714,790	1.03
Maine	12,000	1,681	376,186	1.57
Michigan	7,690,253	[a] 149,736	[b] 178,826,486	1.16
Montana	2,636,895	904,058	141,392,503	2.68
Nevada	2,275,748	271,653	45,461,153	1.00
New Mexico	1,954,218	149,274	46,231,608	1.18
Oregon	27,618	7,044	2,087,276	3.78
Utah	5,668,120	283,975	108,087,350	.95
Vermont	23,400	1,395	582,468	1.24
Washington	66,954	3,748	1,375,921	1.03
Total and average	30,769,966	2,485,651	829,473,686	1.35

State.	Ore leached.[c]			Ore smelted.		
	Quantity.	Copper produced.	Percentage of copper.	Quantity.	Copper produced.	Percentage of copper.
	Short tons.	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska				41,199	10,222,251	12.41
Arizona	1,543,373	36,089,438	1.17	2,263,761	244,357,252	5.40
California				97,850	8,844,685	4.52
Colorado				9,417	774,435	4.11
Georgia				350	8,306	1.19
Idaho				16,862	1,830,254	5.43
Montana	272,084	3,809,343	.70	172,472	20,120,001	5.83
Nevada	1,182	45,807	1.94	86,259	6,535,129	3.79
New Mexico				72,889	4,766,460	3.27
North Carolina				17	3,334	9.81
Oregon				602	127,185	10.56
South Carolina				16	2,299	7.18
Tennessee				555,018	15,623,589	1.41
Texas				16	979	3.06
Utah	69,137	360,905	2.61	146,861	7,863,829	2.68
Washington				1,493	293,139	9.82
Wyoming				798	139,900	8.77
Total and average	1,885,776	40,305,493	1.07	3,465,880	321,513,027	4.64

[a] Includes concentrates from sands.
[b] Includes copper from sands.
[c] Does not include old tailings treated.

Copper produced from copper-lead and copper-zinc ores in the United States in 1919.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper.
	Short tons.	*Pounds.*	
Arizona	7,261	30,248	0.21
Colorado	1,690	193,197	5.72
Idaho	19	1,328	3.49
Montana	1,357	97,616	3.60
Nevada	4,996	24,871	.25
New Mexico	320	38,433	6.01
Utah	1,924	125,645	3.27
Washington	65	4,025	3.10
Total and average	17,632	515,363	1.46

Copper derived from ores classed as copper-bearing (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in the United States in 1919.

State.	Ore treated.	Copper recovered.	Percentage of copper.	Copper from all sources, including old slags, smelter cleanings, and precipitates.
	Short tons.	*Pounds.*		*Pounds.*
Alaska	492,644	45,058,171	4.57	47,220,771
Arizona [a]	13,354,443	537,231,485	2.01	538,100,844
California	486,433	21,592,163	2.22	21,732,507
Colorado [b]	11,107	967,632	4.36	3,560,207
Georgia	350	8,306	1.19	8,306
Idaho	51,565	2,546,372	2.47	3,122,763
Maine	12,000	376,186	1.57	376,186
Michigan	7,690,253	178,826,486	1.16	178,826,486
Missouri				1,617,200
Montana [c]	3,082,808	165,419,463	2.68	169,981,288
Nevada	2,368,185	52,066,960	1.10	52,331,175
New Mexico [d]	2,027,427	51,036,501	1.26	51,150,541
North Carolina	17	3,334	9.81	3,334
Oregon	28,220	2,214,461	3.92	2,214,815
South Carolina	16	2,299	7.18	2,299
Tennessee	555,018	15,623,589	1.41	15,623,589
Texas	16	979	3.06	979
Utah	5,886,042	116,437,729	.99	124,061,807
Vermont	23,400	582,468	1.24	582,468
Washington	68,512	1,673,085	1.22	1,676,576
Wyoming	798	139,900	8.77	139,900
Total and average	36,139,254	1,191,807,569	1.65	1,212,334,041

[a] A quantity of copper was recovered from old slags and ores not classed as copper ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Considerable copper was recovered as precipitates from mine waters and from ore not classed as copper ores.
[d] A quantity of copper was derived from ores classed as lead ores and siliceous ores.

Copper ores produced in the United States, 1906–1919, and average yield in copper, gold, and silver.

Year.	Copper ores.	Yield in copper.	Yield per ton in gold.	Yield per ton in silver.	Value per ton in gold and silver.
	Short tons.	*Per cent.*	*Ounce.*	*Ounce.*	
1906	18,000,000	2.50	0.0150	0.882	$0.856
1907	20,253,000	2.11	.0135	.609	.682
1908	[a] 22,290,886	2.07	.0104	.666	.560
1909	27,932,618	1.98	.0097	.655	.540
1910	28,497,238	1.88	.0093	.562	.495
1911	29,988,235	1.82	.0089	.555	.492
1912	35,656,414	1.71	.0073	.517	.468
1913	36,336,682	1.67	.0057	.502	.420
1914	[b] 35,175,541	1.60	.0075	.422	.39
1915	43,404,182	1.66	.0078	.428	.38
1916	57,863,365	1.70	.0069	.424	.42
1917	58,482,694	1.60	.0058	.347	.49
1918	62,289,069	1.51	.0050	.328	.50
1919	36,121,622	1.65	.0052	.356	.51

[a] Includes 143,675 tons of slag smelted.
[b] Includes 99,816 tons of slag smelted and ore leached.

Copper ores produced in the United States, 1906–1919, classified as smelting and concentrating ores, and average yield in copper.

Year.	Smelting ores.		Concentrating ores.	
	Quantity.	Yield in copper.	Quantity.	Yield in copper.
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*
1906	3,278,000	.....	14,722,000	.....
1907	3,957,500	4.05	16,295,500	1.41
1908	4,386,689	4.27	17,760,522	1.485
1909	5,267,707	4.15	22,664,911	1.47
1910	5,001,394	4.14	23,495,844	1.40
1911	4,355,650	4.66	25,632,585	1.34
1912	5,014,018	4.45	30,642,396	1.26
1913	5,290,310	4.22	31,046,372	1.22
1914	4,597,398	4.23	30,478,327	1.20
1915	5,433,907	4.60	37,970,275	1.26
1916	6,928,010	4.72	50,935,355	1.28
1917	7,438,068	4.39	51,044,626	1.19
1918	6,223,674	4.51	53,937,796	1.18
1919	3,465,880	4.64	30,769,966	1.35

The output of copper-bearing ores in 1919 showed a marked decrease compared with that of 1918. For the last 14 years there has been a steady increase in production of these ores except in 1914 and 1919. Arizona is the largest producer of copper ore, followed in order by Michigan, Utah, Montana, Nevada, New Mexico, Tennessee, Alaska, and California. In the output of smelting ore Arizona is first, followed by Tennessee, Montana, Utah, California, Nevada, and New Mexico. In the output of concentrating ore Arizona is first, followed by Michigan, Utah, Montana, Nevada, and New Mexico.

YIELD OF COPPER FROM ORES.

The average yield of copper from copper ore in 1919 was 1.65 per cent. There was a steady decrease in the average yield of copper from copper ores from about 2.50 per cent in 1906 to 1.60 per cent in 1914. The yield showed an increase in 1915 and 1916, was less in 1917 and 1918, and increased again in 1919.

The average yield from direct smelting ores has increased from 4.05 per cent in 1907 to 4.64 per cent in 1919; that from concentrating ores decreased from 1.48 per cent in 1908 to 1.20 per cent in 1914, increased to 1.28 per cent in 1916 owing to improved metallurgic processes, decreased to 1.18 per cent in 1918, and increased again to 1.35 per cent in 1919.

Of the important copper-producing States Alaska produced the highest grade of copper ore in 1919, followed in order by Montana, California, Arizona, Tennessee, New Mexico, Michigan, Nevada, and Utah. Of the States producing smelter ore in large quantity Montana had the highest yield, followed by Arizona, California, Nevada, New Mexico, Utah, and Tennessee.

Of the States producing concentrating ores in large quantity Montana had the highest grade, followed by Arizona, New Mexico, Michigan, Nevada, and Utah.

The average recovery of gold and silver from copper ores shows a variation about in proportion to that of copper. In 1906 copper ores averaged 85.6 cents to the ton in gold and silver; in 1919 the average yield was 51 cents to the ton. Among the principal copper-producing

States Montana was first in the average yield of gold and silver per ton of ore, followed by Alaska, California, Arizona, Michigan, Utah, New Mexico, Tennessee, and Nevada.

REVIEW BY STATES.

SCOPE OF DISCUSSION.

In the following pages a brief statement of the conditions affecting production in the principal copper districts of the country is presented, and the tenor of the ore from each district is given, so far as it does not disclose the production of those individual companies whose figures of output have not already been published in their annual reports or elsewhere. Those who desire more detailed information on the mining operations of the districts are referred to the reports on mine production in the several States, which form other chapters of Mineral Resources, as set forth in the prefatory note.

Figures of metal output, ore reserves, metal content, and recovery in treatment of individual companies given in this report, unless otherwise stated, are quoted from the official reports of the companies.

The report for 1915 contains a map showing the location of the copper-producing districts and the metallurgic plants and also a brief discussion of the geologic occurrence of the ores in the different districts. Copies of that report may be obtained on application to the Director of the United States Geological Survey.

ALASKA.

The production of blister copper from Alaska in 1919 was 56,534,992 pounds, as compared with 67,081,648 pounds in 1918. The mine production of copper in 1919 was 47,220,771 pounds.

Alaska began to produce copper in notable quantity about 1903, and since that time it has been a steady contributor. Its total production of blister copper to the end of 1919 is 532,355,546 pounds. The output in 1919 came from the Ketchikan, Prince William Sound, and the Copper River districts.

Ketchikan district.—The copper mines in the Ketchikan district yielded 8,936 tons of ore, from which 629,100 pounds of copper was produced.

The It mine, at Kasaan Bay, was operated by the Granby Consolidated Mining Co. For the fiscal year ending June 30, 1919, it produced 1,560 tons of ore, compared with 11,776 tons in 1918. Considerable development work was done, but in the last half of the year the mine was abandoned.

The Mamie mine was closed in July, 1918, owing to the destruction by fire of the compressor house. Very little if any ore of commercial value remains in the mine.

Prince William Sound district.—Copper mining in the Prince William Sound district in 1919 was active. The ores of the district were shipped to the Tacoma and Anyox smelters. The largest producer was the Beatson–Bonanza mine, but the Ellamar and other copper properties shipped ore.

Copper mines of this district produced 288,077 tons of ore yielding 10,300,281 pounds of copper, 74,047 ounces of silver, and 2,412 ounces of gold.

There was mined from the Beatson mine of the Kennecott Copper Corporation 264,460 tons of ore, averaging 1.95 per cent of copper. The ore milled during the year amounted to 264,265 tons, averaging 1.95 per cent of copper. Concentrates amounted to 28,204 tons, averaging 14.78 per cent of copper. The average recovery was 80.80 per cent, this being a slight improvement over previous years.

Copper River district.—The Bonanza and Jumbo mines of the Kennecott Copper Corporation were the largest producers in the Copper River district. The Mother Lode Coalition Mines Co., of the Chitina district, also produced in 1919.

During the year there was mined from the Bonanza and Jumbo mines 162,248 tons of ore, averaging 10.24 per cent of copper; 148,768 tons of ore milled averaged 8.44 per cent of copper. Concentrates amounted to 20,128 tons, averaging 53.89 per cent. The average recovery was 85.94 per cent. The leaching plant treated 143,329 tons of tailings, averaging 1.02 per cent of copper, with a recovery of 2,162,600 pounds of copper. The total average milling recovery for the year, including leaching-plant operations, was 92.96 per cent, exceeding by 3.58 per cent the recovery in 1918.

In addition to the Kennecott ores above noted the Kennecott mill also treated 33,612 tons of ore for the account of the Mother Lode Coalition Mines Co.

The total recovery from the Copper River and Beatson output was 38,577,418 pounds of refined copper and 432,992 ounces of silver.

Profit on metal sold and delivered by the Kennecott Copper Corporation amounted to $2,541,107, and total profits, including dividends on stock held by the company, amounted to $3,938,381.

Dividends were paid to the amount of $2,787,073, and in addition a capital distribution of $2,787,073 was made.

ARIZONA.

Arizona began an intermittent production of copper about 1862, but the production was small until about 1875. Since 1880 the development of the industry has been both steady and rapid. Inclusive of 1919, Arizona has made a recorded production of 7,792,771,546 pounds, which represents 27.45 per cent of the total production of the United States since 1845. In 1919 the production was 536,515,368 pounds, or 41.71 per cent of the total production of the United States for the year. The greater part of the production has come from five copper mining districts. Twelve of the thirteen copper-smelting plants within the State operated in 1919. The principal districts in the order of their total output are Bisbee, Morenci-Metcalf, Globe-Miami, Jerome, Ray or Mineral Creek, Ajo, Pioneer, and Silver Bell.

As a result of the curtailment in output, of the further increase in rates of wages and of the continuing increase in cost of supplies, the operating cost showed some increase in practically all districts.

Bisbee district.—Bisbee was the first district in Arizona to make a large production of copper. Since 1906 this district has not produced less than 110,000,000 pounds a year. Practically all the copper produced in the district, except that from the Sacramento Hill area, is derived from ore which occurs as irregular replacement deposits in limestone without definite arrangement. On account of the character of the occurrence of the ore the cost of prospecting

has always been rather high and the irregular character of the ore bodies together with the heavy ground, particularly with the oxidized ore bodies, has been responsible for the relatively high cost of extraction. In recent years the large disseminated ore body in the altered granite porphyry of the Sacramento Hill area has been discovered and developed. The principal producing companies of the district whose operations are summarized in the following tables are the Phelps Dodge Corporation, the Calumet & Arizona Mining Co., and the Shattuck Arizona Copper Co. The abnormal condition of the copper industry greatly affected the operations in this district and reductions in production from one-half to one-third of normal were made to accommodate the industry to the unfortunate conditions.

As is the case with many other districts, the tremendous war demands and the inefficiency and shortage of labor made the normal amount of development work necessary to the life of the mines impossible during the war. The curtailment of output and the poor market turned the attention of most of the producers to the campaign of unimpeded development work. As great inroads had been made on the developed reserves, renewed development work had become essential, and, though it does not appear to have changed the statistical reports, the operations during the year were of very great importance and value to the industry, and their effect will be felt when conditions warrant resumption of normal operations.

The Phelps Dodge Corporation was, as usual, the largest producer in the district, and its production was 68,614,002 pounds. The following tables give a summary of the operations during the year:

Copper produced in Bisbee district, Ariz., 1906–1919.

Year.	Quantity.	Average yield in copper.	Value in gold and silver per ton.	Year.	Quantity.	Average yield in copper.	Value in gold and silver per ton.
	Pounds.	*Per cent.*			*Pounds.*	*Per cent.*	
1906	131,000,000	6+	.....	1913	155,100,000	5.6	$1.16
1907	110,000,000	6+	.....	1914	151,600,000	5.4	1.35
1908	129,000,000	6+	.....	1915	164,600,000	5.0	1.66
1909	130,000,000	6+	.....	1916	193,600,000	4.9	1.51
1910	142,500,000	5.4	$1.07	1917	167,600,000	5.0	1.56
1911	130,200,000	5.9	1.42	1918	160,456,000	4.9	1.62
1912	140,000,000	5.6	1.41	1919	122,311,000	4.87	2.21

The production of the Copper Queen branch of the Phelps Dodge Corporation, as summarized in the company's report, is as follows:

Metals produced by Copper Queen branch of Phelps Dodge Corporation, 1919.

Production of mines.

	Ore, dry weight.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*
Shipped to Douglas	594,128	10,784	490,743	67,974,509	.....
Shipped to El Paso	29	3	850	390	9,372
Shipped to experimental concentrator	8,027	.....	.....	.....	.....
Precipitates	612	.....	73	415,767	.....
Slag and flue dust	1,910	1	284	48,458	.....
Concentrates shipped	1,680	25	376	174,878	.....
	606,386	10,813	492,326	68,614,002	9,372

Metals produced by Copper Queen branch of Phelps Dodge Corporation, 1919—Contd.

Production of reduction works.

	Ore, dry weight.	Gold.	Silver.	Copper.
	Short tons.	*Ounces.*	*Ounces.*	*Pounds.*
Copper Queen branch	515,461	9,491	381,923	56,726,353
Burro Mountain branch	24,875	119	17,592	7,272,109
Moctezuma Copper Co.	118,910	4,992	544,106	27,741,636
All other	86,861	3,838	560,766	5,900,759
	746,107	18,440	1,504,387	97,640,857

Metals produced by Copper Queen Consolidated Mining Co., 1911–1919.

Year.	Ore.	Copper.	Silver.	Gold.	Lead.	Earnings.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Pounds.*		
1911	619,132	74,489,728	1,227,453	16,895	5,658,930	$4,155,010	$5,200,000
1912	786,368	88,280,908	1,027,130	18,023	2,953,685	6,977,378	5,707,351
1913	867,481	97,181,725	919,138	16,213	5,701,628	6,916,900	5,700,000
1914	732,829	86,066,143	1,036,672	15,769	8,889,175	6,042,001	4,500,000
1915	833,107	88,551,180	943,368	18,974	9,388,418	.....	.....
1916	951,978	102,685,722	1,096,136	24,030	9,421,562	.....	.....
1917	800,970	93,618,409	828,665	19,156	6,870,128	.....	.....
1918	771,063	90,988,156	558,433	16,409	1,234,497	.....	.....
1919	606,386	68,614,002	492,326	10,813	9,372	.....	.....

The company reduced its production to about one-half of the production in 1918 and, as far as the exigencies of the labor situation and the shortage of material would permit, undertook a considerable amount of development work. In order to facilitate development work and to assist in bettering the statistical condition of the company, work on all branches whose costs were highest and whose need for underground development was greatest was completely suspended and operations were confined to those branches where the greatest advantage could be obtained.

During the year extensive experimental and test work was conducted in connection with the concentrating problems of the new Bisbee mill and the Tyrone and Nacozari plants. The ore reserves at the Copper Queen mines showed a small decrease in quantity, but the grade of ore was higher than in preceding years.

At the Sacramento Hill porphyry mine stripping operations were continued satisfactorily throughout the year at reduced costs and with increased efficiency. At this mine 2,056,700 cubic yards of waste material was removed, making a total of about 3,377,022 cubic yards, which represents approximately 75 per cent of the total waste to be removed before extraction can be commenced.

The following table indicates the operation of the Calumet & Arizona Mining Co.'s plant for the year 1919:

Metals produced by Calumet & Arizona Mining Co., including the Superior & Pittsburgh Co., before the consolidation of the two, 1911–1919.

Year.	Company.	Ore smelted.	Copper produced.	Copper recovered.	Gold.	Silver.	Dividends.
		Short tons.	*Pounds.*	*Per cent.*	*Ounces.*	*Ounces.*	
1911	Calumet & Arizona	231,135	21,476,739	4.487	9,329	216,987	$1,989,059
	Superior & Pittsburgh	230,620	28,469,166	6.1859	8,785	236,960	1,739,758
1912	Calumet & Arizona	169,287	16,490,229	4.34	9,066	233,092	2,542,781
	Superior & Pittsburgh	318,418	36,618,399	5.762	13,815	361,227	1,919,733
1913	Calumet & Arizona	111,541	52,621,651	4.485	15,890	540,214	3,059,208
	Superior & Pittsburgh	376,568		5.785			
1914	Calumet & Arizona	540,468	49,992,909	4.62	19,744	573,606	1,851,008
1915	do	729,677	63,126,931	4.33	26,212	947,129	2,006,557
1916	do	845,286	70,702,028	4.17	31,673	1,267,734	5,777,296
1917	do		59,131,512		27,947	906,038	6,424,762
1918	do		50,909,373		31,308	906,210	5,140,062
1919	do		44,991,107		28,530	995,366	1,927,563

At the reduction works at Douglas 701,450 tons of ore was treated. The sulphuric-acid plant produced 48,596 tons of 60° Baumé acid.

Net income for the year was $524,416. Regular dividends for the year amounted to $1,927,563. Total dividends to the end of 1919 amounted to $43,060,386.

The Calumet & Arizona Mining Co. curtailed its output to 60 per cent of normal in February, 1919, when the Oliver and Cole mines were shut down and the operations were concentrated on the Junction and Briggs mines. The development work was curtailed to even a greater degree than production.

The New Cornelia Copper Co. also curtailed its production, and in spite of the high cost of labor and of supplies the operating costs were considered satisfactory. Development work at the New Cornelia mine was confined very largely to diamond drilling, which resulted in the development of 1,085,356 tons of sulphide ore, averaging 1.25 per cent of copper. The leaching operation of the company was considered satisfactory, and, as a result, additions to the leaching operations are planned.

The Shattuck Arizona Co. also curtailed its output early in the year. There was no unusual occurrence in the mine except an underground fire that caused the suspension of operations for a considerable period. When the fire was under control the extraction of copper ore was resumed on a small scale, and a gradual increase is contemplated as fast as it may be warranted under the general conditions of the industry.

Metals produced by Shattuck Arizona Copper Co., 1911–1919.

Year.	Copper.	Silver.	Gold.	Lead.	Copper recovered.	Dividends.
	Pounds.	*Ounces.*	*Ounces.*	*Pounds.*	*Per cent.*	
1911[a]	4,111,000					
1912[b]	1,253,305	21,008	13		7.13	
1912[c]	1,746,493	15,165	16		6.67	
1913	13,219,756	236,000	2,033	1,483,956	6.67	$525,000
1914	10,846,918	198,419	2,445	14,065	5.79	525,000
1915	11,154,211	201,869	3,151	2,345,342	5.89	875,000
1916	18,161,763	314,918	4,721	3,413,445	5.38	1,662,500
1917	11,935,317	154,344	1,542	2,010,145	4.57	612,500
1918	9,081,959	161,230	1,220	2,420,690	4.83	437,500
1919	2,111,841	89,724	300	4,432,655	4.74	[d] 262,500

[a] Year ending August, 1911.
[b] Year ending August, 1912.
[c] Aug. 1 to Dec. 31, 1912, inclusive.
[d] Capital distribution through 1919, $1,487,500.

Mine and smelter production of Shattuck Arizona Copper Co., 1919.

	Copper ore (dry).	Lead ore (dry).
Tons ore stoped	20,455	45,529
Tons ore developed	1,441	3,621
Tons ore from dumps, etc	115	
Tons ore mined	22,011	49,150
Tons ore shipped	22,116	49,059
Tons ore smelted	22,256	49,363

Copper recovered	pounds	2,111,841
Gold recovered	ounces	300
Silver recovered	do	89,724
Lead recovered from concentrates	pounds	4,432,655
Gold recovered from concentrates	ounces	2,013
Silver recovered from concentrates	do	160,078
Lead recovered, direct shipments	pounds	31,941
Gold recovered, direct shipments	ounces	18
Silver recovered, direct shipments	do	7,947
Cost per pound of refined copper.		
Gross operating cost	cents	27.754
Less operating credits	do	5.354
Net operating cost	do	22.40

Globe-Miami district.—The Globe-Miami district was a silver producer early in the history of mining in the State, but its production of copper did not become important until about 1881 and was intermittent until about 1888. Since 1898, which marked the advent of the railway, the district has ranked among the large copper producers of the country. Inclusive of 1919, the district has produced 1,445,602,000 pounds of copper, which represents 18.55 per cent of the total output of Arizona since 1845. The district ranks sixth in the country and third in the State. The Miami part of the district did not make a notable output until 1911.

Copper produced in Globe-Miami district, Ariz., 1906–1919.

Year.	Copper.	Yield of ore in copper.	Year.	Copper.	Yield of ore in copper.
	Pounds.	*Per cent.*		*Pounds.*	*Per cent.*
1906	27,000,000	3.4	1913	71,000,000	2.38
1907	35,000,000	4	1914	72,000,000	2.41
1908	36,000,000	4.5	1915	98,500,000	2
1909	33,000,000	4.43	1916	220,000,000	1.43
1910	27,600,000	5	1917	169,490,000	1.42
1911	44,600,000	3.35	1918	201,806,000	1.31
1912	61,600,000	2.21	1919	171,106,000	1.36

The chief producers of the district are the Old Dominion Co., the Arizona Commercial Mining Co., the Miami Copper Co., and the Inspiration Consolidated Copper Co. The same condition prevailed in this district as in the others. Production was tremendously decreased, and most companies devoted considerable time and funds to development and prospecting.

Ore produced by Old Dominion Co., 1919.

	Quantity (short tons).	Percentage of copper.
Smelting ore	50,188	6.61
Concentrating ore	200,304	3.69
Converting ore	3,194	4.76
	253,686	4.28

Metals produced by Old Dominion Co., 1911–1919.

Year.	Ore.	Copper.	Gold.	Silver.	Average yield in copper.	Cost per pound of copper.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Per cent.*	*Cents.*	
1911	174,246	19,195,181	936	42,050	5.84	9.5	$486,000
1912	201,181	16,533,993	583	42,750	4.67	10.34	729,000
1913	169,961	18,945,153	419	51,316	5.88	9.7	810,000
1914	129,813	17,816,284	603	33,311	7.44	8.22	445,500
1915	115,459	13,771,681	620	40,632	6.56	8.90	1,053,000
1916	152,059	17,654,643	1,240	60,688	5.88	11.69	1,944,000
1917 [a]	199,888	32,365,795	3,897	165,703	4.97	.....	2,376,262
1918	230,451	33,378,158	5,071	184,982	4.52	.....	1,188,284
1919	253,686	28,166,396	5,756	137,071	4.28	.....	.....

[a] Includes custom ores.

Metals produced by United Globe mines, 1911–1916.

Year.	Ore.	Copper.	Silver.	Gold.	Yield in copper.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Per cent.*	
1911	110,578	8,525,433	111,459	876	3.85	.....
1912	188,254	12,252,073	124,362	789	3.25	$460,000
1913	167,919	11,348,100	119,588	1,537	3.38	690,000
1914	155,205	11,086,674	91,582	1,580	3.57	425,500
1915	141,240	11,536,021	105,109	1,508	4.08	621,000
1916	206,163	14,852,399	128,066	1,543	3.60	1,679,000

Dividends paid by the Old Dominion Co. to December 31, 1918, amounted to $14,405,260. No dividends were paid in 1919.

Total dividends paid by the United Globe mines to the end of 1916 amounted to $4,255,000. In 1917 these mines were combined as the Old Dominion Co.

The smelter of the Old Dominion Co., at Globe, treated 111,533 tons as compared with 165,028 tons in 1918.

A large part of the operations of the Old Dominion Co. for the year consisted in prospecting and development of concentrating ore, which resulted in an increase in reserves from 731,882 tons at the beginning to 1,172,053 tons at the end of the year. These reserves averaged about 2.5 per cent of copper. The development work is considered very encouraging.

The Miami Copper Co. operated during the year at approximately 75 per cent of normal capacity, and the following tables show the results of the operations:

Copper produced by Miami Copper Co., 1911–1919.

Year.	Ore.	Copper content.	Mill extraction.	Refined copper.	Cost of copper per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	
1911	445,036	2.48	73.37	15,385,783	9.103	.....
1912	1,040,744	2.393	69.39	32,832,609	9.5884	$1,100,112
1913	1,058,784	2.30	71.06	32,867,666	10.6086	1,491,989
1914	1,096,633	2.28	69.93	33,296,010	9.2045	1,120,375
1915	1,348,122	2.17	75.17	41,832,059	8.76	1,681,004
1916	1,842,017	2.07	73.88	53,518,331	9.52	4,295,905
1917	1,640,206	2.03	69.25	43,863,669	12.51	6,537,247
1918	2,132,941	2.026	71.15	58,407,563	14.833	3,362,013
1919	1,698,446	2.04	82.38	54,221,638	15.812	1,867,785

Milling operations of Miami Copper Co., 1919.

Ore milled	short tons	1,698,446
Copper in ore	per cent	2.040
Concentrates produced	short tons	65,544
Copper in concentrates	per cent	43.540
Copper in concentrates	pounds	57,075,423
Copper recovered per ton of ore	do	33.60
Mill extraction	per cent	82.38

Cost of copper in concentrates f. o. b. cars at Miami, Ariz., 1919.

	Per ton of ore.	Per pound of copper.
Mining	$1.54030	$0.04825
Milling	.92444	.02896
General	.45024	.01410
	2.91498	.09131

Ore reserves of Miami Copper Co., January 1, 1920.

	Quantity (short tons).	Percentage of copper.
High-grade sulphide ore	11,054,349	2.38
Low-grade sulphide ore	36,000,000	1.06
Mixed sulphide and oxide ore	6,000,000	2.00
	53,054,349	.....

Development work was carried on during the year and resulted in only very slight changes in the reserves of high-grade ore; there was no development in the low-grade ore. The top-slice method of mining was replaced during the year by the caving method, but there was little other change in mining operations. The company had some increase in costs, notably the 20-cent increase in the milling cost, which was due very largely to the 50 per cent increase in the cost of power derived from fuel oil.

The Inspiration Consolidated Copper Co. reduced its output largely in 1919, and, though the conditions of labor were somewhat more stable and its efficiency was somewhat increased, the high cost of labor and of supplies resulted in an increased cost of production. The company took advantage of the situation and undertook development work and the renewal and repair of equipment, which were deferred during the World War. The end of the year, according to the company's statement, found the mines and auxiliary plants in a condition to be operated at maximum output when the situation warrants it. The development work during the year was largely confined to the area previously prospected by churn drilling; hence there resulted no increase in reserves, but the reserves were made more accessible.

The production of refined copper by the Inspiration Consolidated Copper Co. for 1919 was 78,038,306 pounds. A total of 4,175,632 tons of ore was mined, of which 4,151,806 tons was concentrating ore and 23,826 tons oxidized ore. The oxidized ore was shipped direct to the smelter.

The average cost of copper exclusive of depreciation and Federal income tax was 13.412 cents a pound.

Mill statistics, Inspiration Consolidated Copper Co., 1919.

Total ore milled	dry tons	4,151,806
Ore milled per day	do	11,501
Average number of sections running		11.6
Average rate per section	tons	991.4
Screen analysis of feed (on 48 mesh)	per cent	4.2
Assay mill feed	per cent of copper	1.304
Copper in feed, oxidized	per cent	.263
Copper assay of general tailings	do	.346
Copper in general tailings, oxidized	do	.245
Copper in general concentrates, smelter assay	do	28.750
Copper in flotation concentrates	do	32.77
Copper in table concentrates	do	10.49
Moisture in general concentrates	do	19.61
Ratio of concentration		34.0
Recovery of copper calculated from (smelter assays):		
Assays only	per cent	74.36
Assays and weights of concentrates and ore	do	73.69
Assays and weights of concentrates and tailings	do	74.18
Assays and weights of ore and tailings	do	74.35
Recovery of copper sulphides	do	90.63
Water used per ton of ore	gallons	405
Power used per ton of ore milled:		
Coarse crushing	kilowatt-hours	.46
Fine grinding and concentrating	do	9.98
Blowers for flotation air	do	2.16
Filtering and reclaiming water	do	1.31
Lighting	do	.13
Steel balls consumed per ton of ore milled	pounds	1.706
Flotation oil consumed per ton of ore milled:		
Coal tar	do	1.24
Other oils	do	.10

The Arizona Commercial Mining Co. operated throughout the year, and in addition to the extraction of ore carried on considerable exploration and development work.

Copper produced by the Arizona Commercial Mining Co. in 1918 and 1919.

	1918		1919	
	Dry tons.	Copper.	Dry tons.	Copper.
		Per cent.		*Per cent.*
Smelting ore	11,712.161	10.268	11,393.388	9.113
Concentrating ore	51,052.908	4.863	65,168.934	4.941
Secondary smelter products	18.445	17.760		
Lease ore	13.364	5.620	9.964	11.900
	62,796.878	5.874	76,572.286	5.563

The ores extracted in 1919 were shipped to the Old Dominion Co. and yielded 7,280,861 pounds of fine copper, 16,917.652 ounces of silver, and 1,310.002 ounces of gold.

Morenci-Metcalf district.—The Morenci-Metcalf district is one of the oldest copper-producing districts in Arizona. Production began about 1873, and since 1880 the district has made a large contribution to the copper production of the United States. Inclusive of 1919 it has produced a total of 1,466,931,000 pounds, or 5.17 per cent of the total output of the country since 1845. In total production it ranks fifth among the copper districts of the country, and for 1919 it ranked ninth. The principal producers of the district are the Morenci branch of the Phelps Dodge Corporation, the Arizona Copper

Co., and the Shannon Copper Co. Apart from the conditions outlined above as prevailing in other districts, nothing unusual developed in 1919 in the Morenci-Metcalf district.

Copper produced in Morenci-Metcalf district, 1906–1919.

Year.	Quantity.	Average yield of copper from ore.	Year.	Quantity.	Average yield of copper from ore.
	Pounds.	*Per cent.*		*Pounds.*	*Per cent.*
1906	56,000,000	.....	1913	70,100,000	2.00
1907	63,000,000	.....	1914	66,000,000	1.95
1908	77,000,000	.....	1915	51,096,000	2.01
1909	72,000,000	2.29	1916	75,977,000	1.89
1910	73,154,000	2.35	1917	53,000,000	1.85
1911	71,500,000	2.29	1918	71,867,000	1.71
1912	79,900,000	2.21	1919	44,868,000	1.72

It is interesting to note that the Morenci branch of the Phelps Dodge Corporation, whose operations are shown below, has installed four Diesel prime movers as a source of its power.

Copper produced by Morenci branch of Phelps Dodge Corporation, 1911–1919.

Year.	Ore treated (short tons).	Copper produced.		Dividends.
		Quantity (pounds).	Percentage.	
1911	517,087	22,704,398	2.29	$800,000
1912	520,272	24,802,789	2.38	1,464,610
1913	537,324	22,255,130	2.07	780,000
1914	477,581	20,272,607	2.12	280,000
1915	376,604	15,333,976	2.03	.....
1916	474,808	17,541,258	1.85	.....
1917	333,263	13,202,201	1.98	.....
1918	480,407	17,130,209	2.32	.....
1919	253,208	11,414,031	2.25	.....

Copper produced by Morenci branch of Phelps Dodge Corporation, 1919, by kinds of ore.

	Ore treated.	Copper produced.	Assay of original ore.	Yield.
	Short tons.	*Pounds.*	*Per cent.*	*Per cent.*
Concentrating ore	228,488.8	8,116,562	2.365	1.776
Smelting ore	21,026.1	2,876,121	7.283	6.839
Old tailings	817.3	48,088	3.153	2.942
Siliceous ore to converters	2,876.1	373,260	6.724	6.489
	253,208.3	11,414,031	2.826	2.254

Result of concentration operations by the Morenci branch of Phelps Dodge Corporation, 1919.

	Quantity (short tons).	Average assay (per cent of copper).
Ore concentrated	223,134.6	2.367
Concentrates produced	32,996.4	12.780
Tailings	190,138.2	.545

Saving	per cent.	80.220
Ratio of concentration		6.762
Proportion of actual running time to total time	per cent.	78.160

Result of smelting and converting operations of Morenci branch of Phelps Dodge Corporation, 1919.

Concentrates	short tons	33,319.5	
Ore	do	20,930.3	
Old slag	do	3.5	
Precipitates	do	92.3	
			54,345.6
Secondaries:			
Converter slag and cleanings	do	14,587.9	
Furnace cleanings	do	473.2	
Flue dust	do	15,204.8	
			30,265.9
Flux:			
Limestone	do		16,800.0
			101,411.5

The Arizona Copper Co. (Ltd.) operated during the year at a reduced rate and had the same difficulties resulting from high wages and high cost of material that were experienced by the other companies in the State. The company reports that the increase in cost of labor and of material has raised the cost of production about 100 per cent since 1915. Development work was carried on through 1919 and has resulted satisfactorily. The Arizona Co., according to its statement, has acquired the mines of the Shannon Copper Co. This company had exhausted its high-grade ore but still owned large bodies of low-grade ore which can probably be mined at a profit when the labor situation has adjusted itself to the new conditions.

Copper produced by Arizona Copper Co., 1911–1919.

Year ending Sept. 30.	Ore treated.	Copper produced.	Average yield.	Year ending Sept. 30.	Ore treated.	Copper produced.	Average yield.
	Short tons.	*Pounds.*	*Per cent.*		*Short tons.*	*Pounds.*	*Per cent.*
1911	744,746	34,584,000	2.32	1916	905,486	34,100,000	1.803
1912	927,116	38,132,000	2.057	1917	1,178,087	42,482,000	1.830
1913	936,903	34,226,000	1.938	1918	1,095,568	40,442,000	1.754
1914	1,079,950	38,756,000	1.808	1919	1,147,659	36,474,000	1.610
1915	968,566	37,330,000	1.961				

The Shannon Copper Co. made no production for the year, as the mines and plants were closed early in 1919. The property, as already stated, is reported to have been acquired by the Arizona Copper Co. (Ltd.).

Metals produced by Shannon Copper Co., 1911–1917.

Year.	Ore treated.	Copper produced.	Average yield in copper.	Gold.	Silver.	Dividends.
	Short tons.	*Pounds.*	*Per cent.*	*Ounces.*	*Ounces.*	
Year ending August, 1911	263,975	15,168,102	2.845	1,690	91,955	.....
Year ending August, 1912	285,210	16,406,336	2.876	2,615	170,690	$150,000
August to December 31, 1912	95,235	5,149,805	2.704	1,012	54,394	.....
1913	434,307	18,793,724	2.163	3,412	169,197	150,000
1914	193,297	9,003,169	2.33	1,295	60,603	.....
1915	.....	6,017,642	.....	690	35,449	.....
1916	.....	9,364,968	.....	1,327	62,935	150,000
1917	.....	6,138,219	.....	1,096	51,771	525,000

Jerome district.—The Jerome district entered the mining world as a producer of gold and silver. In 1883 it began the production of copper. Since 1888 it has been a steady producer of copper, and inclusive of 1919 it has produced 1,207,453,000 pounds of copper, or 4.25 per cent of the total output of the country since 1845. In total output it stands seventh among the copper districts of the country, and in production for 1919 it ranks sixth. The principal producers of the district are the United Verde Copper Co. and the United Verde Extension Mining Co.

Copper produced in Jerome district, Ariz., 1906–1919.

	Pounds.		Pounds.		Pounds.
1906	38, 500, 000	1911	33, 200, 000	1916	102, 000, 000
1907	33, 000, 000	1912	31, 680, 000	1917	145, 900, 000
1908	36, 000, 000	1913	35, 300, 000	1918	133, 781, 000
1909	36, 700, 000	1914	30, 000, 000	1919	72, 333, 000
1910	38, 600, 000	1915	53, 260, 000		

The United Verde Extension Mining Co. operated throughout the year and met the same general difficulties that were experienced by other companies. On account of a strike in the mining district smelting and mining operations were suspended for four months, but they were resumed in the early part of June.

Copper produced by the United Verde Extension Mining Co., 1918–19.

Year.	Ore treated.	Copper produced.	Silver.	Gold.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*
1918	133, 535	55, 491, 077	503, 739	3, 046
1919	93, 325	28, 860, 615	272, 855	3, 169

Ray or Mineral Creek district.—The operations of the Ray Consolidated Copper Co. were reduced about 50 per cent in 1919. Some development but no exploration work was done. The mining of carbonate ore from the surface was entirely suspended early in the year. The extraction of ore was confined almost entirely to the lower grades of sulphides. The company had the experience, uncommon in 1919, of a small cost of production, particularly as to mining.

Copper produced by Ray Consolidated Mining Co., 1911–1919.

Year.	Ore milled.	Copper content.	Mill recovery.	Refined copper.	Cost per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	
1911	681, 519	1. 83	63. 1	14, 935, 047	10. 75	.....
1912	1, 565, 875	1. 677	68. 278	34, 674, 275	9. 828	.....
1913	2, 365, 296	1. 719	66. 09	52, 341, 029	9. 783	$1, 631, 504
1914	2, 427, 700	1. 76	67. 88	57, 004, 281	8. 839	1, 089, 322
1915	2, 848, 969	1. 673	64. 11	60, 338, 936	9. 497	1, 872, 319
1916	3, 332, 340	1. 607	70. 20	74, 983, 540	10. 267	4, 337, 955
1917	3, 560, 900	1. 635	74. 53	88, 582, 649	12. 229	6, 624, 151
1918	3, 411, 000	1. 613	74. 92	83, 599, 160	17. 695	5, 125, 831
1919	1, 621, 600	1. 814	79. 45	46, 011, 371	15. 62	3, 154, 358

Ajo district.—The principal producer in the Ajo district for the year 1919 was the New Cornelia Copper Co., whose operations are discussed with those of the Calumet & Arizona Mining Co. on page 562. It was estimated at the end of 1918 that the New Cornelia Co. had

fully developed 51,320,421 tons of copper ore, averaging about 1.57 per cent. About 41,000,000 tons is sulphide ore. There were mined and delivered in 1919 to the experimental concentrating plant, which was under construction in 1918, 14,025 tons of sulphide ore, the results of whose treatment are shown below:

Operations of the experimental concentrating plant of the New Cornelia Copper Co. in 1919.

Ore treated	wet tons	14,025
Do	dry tons	13,847
Mill feed:		
Copper as sulphide	per cent	1.275
Copper as oxide	do	.038
Tailings:		
Copper as sulphide	do	.203
Copper as oxide	do	.028
Concentrates:		
Produced	dry tons	938
Total copper	per cent	16.219
Insoluble	do	40.77
Sulphur	do	18.30
Iron	do	18.93
Gold per ton	ounce	0.075
Silver per ton	do	.729
Recovery	per cent	83.61
Recovery, sulphide copper	do	85.19
Ratio of concentration		14.767

Pioneer district.—The Pioneer district in Pinal County made a considerable production in 1919.

The Magma Copper Co. is the largest producer in the district. The development work carried on by this company in 1919 was considered satisfactory, and has determined the increased reserves of ore both laterally and in depth.

Copper ore mined and treated and milling results of the Magma Copper Co., 1919.

	Ore.	Copper.	Silver.	Gold.
	Short tons.	*Per cent.*	*Ounces.*	*Ounce.*
Copper-sulphide ore	89,156.5	5.943	4.974	0.0532
Hand-sorted crude sulphide shipped direct to smelter	12,948.0	16.495	11.806	.1091
Mill heads	76,208.0	4.151	3.812	.0437
Concentrates produced	27,555.0	10.991	10.372	.1148

The mill recovery was 95.74 per cent of the total copper in the mill heads. The total copper recovery, including ore obtained by hand sorting, was 97.46 per cent of the copper contents of the mine-run ore.

The net production, after deducting all smelting and refining losses, was 9,698,902 pounds of copper, 416,773 ounces of silver, and 4,577 ounces of gold.

Copper shipments of Magma Copper Co., from beginning of operations to end of 1919.

	Ore	Copper.	Silver.	Gold.
	Short tons.	*Per cent.*	*Ounces.*	*Ounce.*
Copper concentrates	127,761.9546	12.72	12.278	0.1258
Crude sulphides	65,175.0155	16.521	15.814	.0975
Crude carbonate	4,433.624	8.014	5.266	.0550
	197,370.5941	13.450	13.288	.1149

The net production to date, after deducting all smelting and refining losses, has been 53,095,053 pounds of copper, 2,622,831 ounces of silver, and 22,688 ounces of gold.

Estimated ore reserves of Magma Copper Co. at end of 1919.

	Ore.	Gold per ton.	Silver per ton.	Copper.	Lead.	Zinc.
	Short tons.	*Ounce.*	*Ounces.*	*Per cent.*	*Per cent.*	*Per cent.*
Reasonably assured copper sulphide ore.	566,000	0.02	4.1	5.44	.....	.....
Reasonably assured lead-zinc ore.....	20,000	.....	12.0	.....	2.0	13.5

Silverbell district.—The Silverbell district, in Pima County, has been a considerable producer of copper since 1904, and has produced about 59,000,000 pounds of copper. The production in 1919 was 2,490,000 pounds. The Silverbell mine, operated by the American Smelting & Refining Co., is the principal producer in the district.

Other districts.—Other districts in Arizona that made considerable production during the year are the Cochise, Courtland-Turquoise, Banner, Helvetia, Pima, Patagonia and Big-Bug, Copper Basin, Peck Planet, and Agua-Fria. The copper produced in these districts is derived principally from lead, lead-zinc, silver, and siliceous ores, from which the production of copper is largely of secondary importance.

CALIFORNIA.

In 1919 California produced 23,548,698 pounds of blister copper, compared with 44,150,761 pounds in 1918.

California was among the earliest of the Western States to make a considerable output of copper. Production began in the foothill belt about 1862 and for several years California was second only to Michigan in output of copper. Later, however, the industry declined, and California did not again attain high rank as a copper producer until 1897, when production from the Shasta County district began. Since that time the State's output has been steady and large. To the end of 1919 California has produced about 768,456,142 pounds of copper, or 2.71 per cent of the output of the country since 1845. In 1919 the output was 1.83 per cent of the total production of the United States. In total output the State ranks sixth among the copper producers of the country and for 1919 it ranked eighth. Three smelting plants in the State treated copper ores in 1919.

The copper has been derived chiefly from ores mined in three districts, although numerous other districts have at various times, particularly in recent years, contributed some copper. Copper mineralization is widely distributed in the State, but so far as known commercial mineralization is confined to the Shasta district, which has made the greatest production, the Foothill district, which made the first production, and the Plumas district.

Shasta district.—The Shasta district is in the southern flank of the Klamath Mountains, at the north end of Sacramento Valley, and is divided by Sacramento River into the Bully Hill-Afterthought, or eastern portion, and the Iron Mountain-Little Backbone, or western portion. Placer mining marked the opening of the district as a metal

producer, which was followed by a considerable production of silver from the copper-deposit gossans, and though copper mineralization had long been recognized production of copper did not begin until 1897, when the Mountain Copper Co. (Ltd.) opened its Iron Mountain mine.

The total production, inclusive of the year 1919, was 573,305,000 or about 2.02 per cent of the total production in the United States. The production in 1919 was only about 0.63 per cent of the total for the year and represents a very marked decline. The district ranked seventeenth in 1919 and ninth in total production.

Many factors, besides the poor market, enter into the decline in the production for 1919. During the war period the extraction of ore was so important and labor was so inefficient and scarce that practically no development work was undertaken, and the result was that the end of the war found many of the mines with their developed reserves almost exhausted. The year 1919 has been utilized in development work under the adverse circumstances of shortage of electric power and inefficiency of labor. Much of the development work, particularly in the tabular ore bodies, has been somewhat discouraging. Some of the mines have recently been entirely closed and others are carrying on nothing but development work. Bully Hill has recently been acquired by strong interests, and it is reported that a considerable quantity of what is locally called "disseminated ore" is being developed. The development in quantity of such ore is very encouraging to the operators, who have very largely exhausted the tabular ore bodies. The results of a thorough geologic study would undoubtedly be very beneficial to all operators, particularly the smaller ones.

Copper produced in Shasta County district, Calif., 1906–1919.

Year.	Quantity (pounds).	Average yield of copper (per ct.).	Gold and silver per ton.	Year.	Quantity (pounds).	Average yield of copper (per ct.).	Gold and silver per ton.
1906	21,000,000	3.6	$3.75	1913	26,800,000	3.59	$1.70
1907	28,000,000	3.0	2.70	1914	25,100,000	3.56	1.28
1908	32,000,000	3.2	2.85	1915	30,500,000	3.29	2.67
1909	48,000,000	3.4	2.02	1916	39,700,000	2.62	2.59
1910	36,000,000	3.0	2.14	1917	26,650,000	2.75	1.00
1911	29,900,000	3.7	1.80	1918	25,030,000	2.76	1.52
1912	26,000,000	3.58	1.84	1919	7,626,000	3.91	2.30

The Mammoth Copper Mining Co. was the principal operator during the year. Much necessary development work was accomplished. The development in the Keystone mine, which belongs to the same company, showed considerable promise.

The copper mines of the Mountain Copper Co. were closed on account of the conditions of market, labor, and transportation, and the operations were confined largely to the mining of pyrite.

In 1919 the principal operations at the Bully Hill and other mines in the district were confined to development.

Foothill district.—The Foothill district is an extensive copper-mineralized area along the foothills of the Sierra Nevada, more or less closely associated with the granodiorite batholith in that area. The first copper produced in California came from this district,

but after a few years of mining, during which the high-grade sulphide and oxidized ore was shipped to Swansea, the district became inactive in 1887.

Copper produced in Foothill district, Calif., 1907–1919.

Year.	Quantity.	Average yield.	Year.	Quantity.	Average yield.
	Pounds.	*Per cent.*		*Pounds.*	*Per cent.*
1907	4,500,000	5+	1914	4,400,000	5.0
1908	4,500,000	4	1915	3,700,000	5.44
1909	5,400,000	4.6	1916	6,460,000	3.07
1910	8,000,000	5.2	1917	8,000,000	4.18
1911	5,500,000	4.7	1918	6,937,000	2.07
1912	6,000,000	5.1	1919	2,048,000	1.69
1913	5,800,000	4.5			

A period of five years of active mining was followed by another period of inactivity, which lasted until 1901. The total yield, including that of 1919, has been about 152,844,000 pounds of copper.

The greatest intensity of mineralization occurs in Calaveras County, and the Penn Mining Co., at Campo Seco, and the Calaveras Copper Co., at Copperopolis, are the chief producers. The ore at Campo Seco occurs principally as primary sulphides in two ore bodies in a greenstone schist, which has apparently developed from the meta-andesite country rock. The Copperopolis deposit, which yielded considerable quantities of high-grade oxidized ore in its early development, occurs in shale which is intruded by and lies in contact with the granodiorite batholith of the region. The ore consists of primary sulphides.

During the period of the war demand for copper great inroads were made into the developed reserves in this district, and 1919 has been devoted to development work, which has been greatly handicapped by poor and insufficient labor.

The Penn Mining Co. smelts its ore to a matte, and the Calaveras Co. is preparing to smelt its ore to blister. Both mines are served by branch lines of the Southern Pacific Co.

Plumas district.—The Plumas copper district is in the Sierra Nevada in Plumas County and is about 20 miles long and probably several miles wide. It lies about 4,000 feet above sea level, and the heavy snowfall somewhat hampers operations in the winter. The district is served by the Western Pacific Railroad.

The ore occurs principally as primary sulphides, though there is some secondary chalcocite and covellite. The country rock is granodiorite and is a part of the Sierra Nevada granodiorite batholith. The mineralization appears to be extensive, and two important mines have been developed. Many promising prospects in the 20 miles between these two mines are being developed, and the district as a whole promises to be a productive one and will perhaps more than compensate for the falling production of other parts of the State. There has been no recent general geologic study of the district, and a thorough investigation according to modern methods would undoubtedly be of material benefit.

The Engels Copper Co., the first to produce, began operations in 1900(?). The distance to the railway and the refusal of the Forest

Service authorities to permit the smelting of ore at the mine made operations at the time impossible. When the Western Pacific Railroad was completed, the company built a 22-mile railway of its own to connect the mine with that line and to furnish an outlet for its ore.

The company is operating two mines about 2 miles apart. In both mines the ore body occurs in noritic diorite and consists principally of primary sulphides. There is considerable sooty chalcocite in the upper mine, but most of the ore is bornite. The company is reported to have blocked out and broken more than 3,000,000 tons of ore, principally bornite, and partly developed 10,000,000 tons of the same material, which averages 2.5 per cent of copper. The ore is concentrated by flotation with excellent results, and the concentrates are shipped to Nevada or Utah for smelting. The year 1919 was devoted to gratifying development work, under the adverse conditions of labor. The mine was in 1918 the largest single producer in the State.

The Walker mine is the other important developed property in the district, and it also shows considerable promise. The ore body at the Walker mine is a quartz vein in an altered diorite, which is thought to be a basic differentiate of the Sierra Nevada granodiorite batholith. The ore minerals are bornite, chalcopyrite, and tetrahedrite. The ore is high grade, ranging from 7 to 12 per cent of copper, and carrying $1 in gold, and 2 to 4 ounces in silver to the ton. It is concentrated and shipped to Tooele, Utah, for smelting.

COLORADO.

In 1919 Colorado produced 4,892,558 pounds of blister copper, compared with 7,591,570 pounds in 1918. Although the State has no important producing district in which copper is the principal metal, yet it ranked tenth among the copper-producing States in 1919. The total recorded output for the State from the beginning of the industry is 279,729,972 pounds, or 0.99 per cent of the total for the United States since 1845.

The copper has been derived mainly from the treatment of mixed ores in which copper was a minor constituent including lead-silver ores and pyritic ores rich in gold and silver. Leadville and the San Juan-Ouray region have been the greatest producers of copper. Much of the output is recovered as matte in lead furnaces.

IDAHO.

During 1919 Idaho produced 3,966,655 pounds of blister copper, compared with 5,836,795 pounds in 1918. The State has made a small and irregular output of copper since 1884, but only since 1903 has it been a steady producer. To the end of 1919 it had a recorded output of 110,556,876 pounds.

Coeur d'Alene region.—The Coeur d'Alene region has been the most productive copper area in the State, though it is not the most productive at the present time. Complete figures for the copper output of the district are not on record. The Snowstorm mine has been the largest copper producer in the district.

Alder Creek district.—There has been intermittent production from the Alder Creek or Mackay district since 1900. In 1919 the mines of the district produced 1,322,000 pounds of copper. The largest producer was the Empire Copper Co.

Other districts.—There are other districts in Idaho, notably that of the Seven Devils region, which contain copper deposits, but owing to lack of transportation facilities they have made but small production.

MICHIGAN.

Michigan was the first important producer of copper in the United States, and, though the Michigan deposits are supposed to have been mined prior to the European exploration of the region, the commercial production dates from 1845. With the development of the Lake Superior mines the United States soon rivaled Chile in the production of copper, and about 1870, owing largely to the tremendous development of these mines, the United States assumed first place as the copper-producing country of the world.

The Lake Superior district has been from the date of its initial production a steady producer, and for many years it was the largest copper-producing district in the world. It is the principal source of the furnace-refined copper known on the market as "Lake" copper. Although the district has been a very active producer for more than 70 years, some of the old mines still have comparatively large reserves of ore, and during the World War new mines were opened. The Lake Superior district shares with the Coro-Coro district of Bolivia the distinction of being the only important producer of copper whose output is derived principally from native copper ores. The total production of refined copper, inclusive of 1919, was 6,706,976,151 pounds and the production in 1919 was 177,594,135 pounds. The principal producing companies in the district are the Calumet & Hecla Mining Co. and its associated companies (the Ahmeek Mining Co., Isle Royale Copper Co., and Osceola Consolidated Mining Co.); the Copper Range Co. and its subsidiaries (the Baltic Mining Co., Champion Copper Co., and Tri-Mountain Mining Co.), the Mohawk Mining Co., the Quincy Mining Co., and the Wolverine Mining Co.

The district had much the same experience as other districts of the United States in 1919, though perhaps the results were more severe.

Copper ore produced in Lake Superior district, Mich., 1906–1919.

Year.	Quantity.	Yield of copper.	Year.	Quantity.	Yield of copper.
	Short tons.	*Per cent.*		*Short tons.*	*Per cent.*
1906	8,904,127	1.26	1913	7,016,370	0.97
1907	9,892,214	1.1	1914	9,269,413	.89
1908	10,531,271	1.06	1915	12,334,700	1.07
1909	11,429,394	1.02	1916	12,364,114	1.08
1910	10,869,561	1.02	1917	12,400,723	.99
1911	10,978,827	1.00	1918	11,321,365	.96
1912	11,411,941	.96	1919	7,690,253	1.16

The statistics in the following tables are compiled from the annual reports to the stockholders of the individual companies:

Ore milled and copper derived therefrom by Michigan companies in 1916, 1917, 1918, and 1919.

[Compiled from the annual reports of the producing companies.]

Company.	1916		1917		1918		1919	
	Quantity.	Yield per ton.	Quantity.	Yield per ton.	Quantity.	Yield per ton.	Quantity.	Yield per ton.
	Short tons.	*Pounds.*	*Short tons.*	*Pounds.*	*Short tons.*	*Pounds.*	*Short tons.*	*Pounds.*
Ahmeek	1,164,010	20.7	1,271,275	22.0	1,196,541	20.8	756,870	22.80
Allouez	566,960	18.02	566,674	15.69	514,888	13.73	235,312	15.94
Baltic	369,287	33.65	325,342	34.47	293,601	34.44	235,832	33.35
Calumet & Hecla	3,166,274	22.53	3,159,570	21.65	2,876,392	20.42	1,830,760	23.91
Centennial	150,617	15.72	148,332	13.50	159,040	15.67	87,688	15.57
Champion	936,656	35.87	776,036	35.50	594,235	36.599	503,030	39.053
Franklin	267,286	.....	303,625	.....	273,964	.....	109,565	.....
Hancock	203,112	.....	302,725	13.22	227,049	13.40	.....	.....
Houghton	19,444	10.55	15,628	11.45	.....	.....	.....	.....
Isle Royale	925,419	13.4	922,160	14.6	974,508	15.9	724,667	17.95
Keweenaw	6,915	9.96	41,148	9.248	.....	.....	.....	.....
La Salle	144,829	9.53	185,014	10.38	176,423	10.388	32,995	10.326
Mass	287,900	16.51	244,671	16.29	196,456	17.33	123,780	15.86
Michigan	.....	.....	2,091	.....	40,865	28.81	62,373	27.21
Mohawk	664,547	20.82	605,202	20.35	454,293	23.73	560,734	22.93
New Arcadian	.....	.....	4,900	.....	10,195	16.0	.....	.....
Osceola	1,284,681	15.2	1,237,805	13.0	1,194,967	13.3	739,364	14.60
Quincy	1,204,026	17.5	1,280,837	17.33	1,174,147	16.99	960,393	20.28
South Lake	.....	.....	[a] 68,388	11.03	7,694	28.09	.....	.....
Superior	185,315	16.38	129,587	16.99	106,213	15.78	27,267	20.68
Trimountain	349,504	24.94	264,655	23.72	201,433	26.52	171,995	30.66
Victoria	146,690	.....	137,286	.....	106,730	14.37	89,206	14.00
White Pine	188,890	22.27	212,889	19.11	194,568	16.83	84,008	23.56
Winona	161,828	13.39	112,082	13.33	57,837	14.157	39,654	14.153
Wolverine	388,898	17.07	352,845	16.60	303,498	15.185	298,089	15.306

[a] Includes from May, 1916, to Dec. 31, 1917.

Copper produced by Michigan mines in 1918 and 1919.

[Compiled from the annual reports of the producing companies.]

Company.	1918	1919			
	Quantity.	Quantity.	Cost per pound.	Price received per pound.	Profit or loss per pound.
	Pounds.	*Pounds.*	*Cents.*	*Cents.*	*Cents.*
Ahmeek	24,851,235	17,223,111	14.02	18.81	+ 4.79
Allouez	7,071,218	3,749,984	21.55	18.76	− 2.79
Baltic	10,406,097	7,864,653	17.53	18.67	+ 1.14
Calumet & Hecla	[a] 67,968,357	[a] 52,859,146	20.16	18.81	− 1.35
Centennial	2,492,857	1,365,148	24.64	18.84	− 5.80
Champion	21,748,514	19,886,917	11.77	18.67	+ 6.90
Franklin	2,827,313	1,062,879	.....	15.00	.....
Hancock	3,041,514	.....	.....	.....	.....
Houghton	.....	.....	.....	.....	.....
Isle Royale	15,442,508	13,007,647	15.80	18.60	+ 2.80
La Salle	1,832,665	340,719	40.86	18.13	−22.73
Mass	3,403,827	1,963,178	27.83	21.70	− 6.13
Michigan	1,177,176	1,697,107	.....	17.68	.....
Mohawk	10,781,041	12,857,392	13.983	17.914	+ 3.931
New Arcadian	164,794	.....	.....	.....	.....
Osceola	15,919,647	10,824,331	18.08	18.65	+ 0.57
Quincy	19,948,965	19,476,320	.....	19.38	.....
South Lake	226,141	.....	.....	.....	.....
Superior	1,676,446	563,935	36.84	18.67	−18.17
Trimountain	5,343,586	5,274,387	17.69	18.67	+ 0.98
Victoria	1,533,536	1,245,590	.....	.....	.....
White Pine	3,273,680	1,979,268	24.30	18.74	− 5.56
Winona	[b] 1,576,683	561,238	.....	.....	.....
Wolverine	4,608,865	4,562,617	20.30	20.60	+ 0.30
	.....	.....	17.482	18.762	+ 1.28

[a] Includes 9,245,388 pounds reclaimed from tailings in 1918 and 9,082,952 pounds in 1919.
[b] Includes 756,826 pounds produced by lessee.

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, and the lake steamers reach the heart of the district by Portage Lake and the Houghton Ship Canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and Duluth, South Shore & Atlantic railways.

The Calumet & Hecla Co. reduced its output to 50 per cent of normal and closed some of its less important workings. The company experienced unusual labor difficulties on account of its inability to compete for labor with the automobile industries in southern Michigan. This unfortunate condition resulted in a more or less unbalanced and inefficient labor organization, which contributed largely to the very high costs of the year 1919. The increased cost of supplies, and particularly the increase in freight on "rock" and coal, also contributed largely to the increased costs. Considerable development work was done during the year 1919–20, including a notable amount of geologic investigation, some of the results of which were considered very satisfactory. The following tables summarize the operations and costs of this company and its associates for the year 1919:

Earnings statements of the Calumet & Hecla Mining Co. and associated companies on copper delivered during 1919.

Calumet & Hecla Mining Co.:		
Received for copper delivered		$5,263,076.90
Cost of copper delivered:		
Production cost	$5,531,380.53	
Selling and delivery costs	135,346.52	
		5,666,727.05
Loss on copper delivered		403,650.15
Loss by reduction to market value		248,636.45
		652,286.60
Ahmeek Mining Co.:		
Received for copper delivered		2,289,032.66
Cost of copper delivered:		
Production cost	$1,645,298.18	
Selling and delivery costs	60,160.89	
		1,705,459.07
Gain on copper delivered		583,573.59
Allouez Mining Co.:		
Received for copper delivered		566,713.12
Cost of copper delivered:		
Production cost	$611,234.38	
Selling and delivery costs	15,127.07	
		626,361.45
Loss on copper delivered		59,648.33
Loss by reduction to market value		25,877.02
		85,525.35
Centennial Copper Mining Co.:		
Received for copper delivered		223,215.07
Cost of copper delivered:		
Production cost	$265,228.80	
Selling and delivery costs	6,015.95	
		271,244.75
Loss on copper delivered		48,029.68
Loss by reduction to market value		25,091.58
		73,121.26

Isle Royale Copper Co.:		
Received for copper delivered		$1,643,150.74
Cost of copper delivered:		
Production cost	$1,394,634.39	
Selling and delivery costs	44,076.63	
		1,438,711.02
Gain on copper delivered		204,439.72
Receipts from sale of silver		94,144.01
La Salle Copper Co.:		
Received for copper delivered		114,467.10
Cost of copper delivered:		
Production cost	$193,961.39	
Selling and delivery costs	3,092.14	
		197,053.53
Loss on copper delivered		82,586.43
Loss by reduction to market value		6,604.92
		89,191.35
Osceola Consolidated Mining Co.:		
Received for copper delivered		1,448,411.79
Cost of copper delivered:		
Production cost	$1,355,111.25	
Selling and delivery costs	38,465.03	
		1,393,576.28
Gain on copper delivered		54,835.51
Superior Copper Co.:		
Received for copper delivered		121,049.89
Cost of copper delivered:		
Production cost	$201,545.69	
Selling and delivery costs	3,131.64	
		204,677.33
Loss on copper delivered		83,627.44
Loss by reduction to market value		22,165.80
		105,793.24
White Pine Copper Co.:		
Received for copper delivered		425,107.33
Cost of copper delivered:		
Production cost	$524,319.81	
Selling and delivery costs	11,357.24	
		535,677.05
Loss on copper delivered		110,569.72
Loss by reduction to market value		32,351.64
		142,921.36

The Copper Range Co. experienced difficulties very similar to those of the Calumet & Hecla Co. and operated on a greatly reduced scale during the year. Although the cost of production was considerably higher than for previous years it was somewhat less than the average selling price of copper for the year 1919. Much of the year was devoted by this company also to development work, none of which resulted in anything particularly important so far as is known. The company obtained a somewhat higher yield of copper from the ores than during the previous years, owing to a more careful selection of "rock."

Copper production of Copper Range Co. for 1919 and average for 10 years.

	Rock stamped.	Refined copper produced.	Cost per pound.	Net earnings.
	Short tons.	*Pounds.*	*Cents.*	
1919	614,342	23,082,498	15.35	$972,653.81
Average for 10 years	1,071,746	28,581,304	10.87	2,293,954.69

The Franklin Mining Co. discontinued its production in May, 1919, and since that time its operations have been confined to the upkeep of the plant, running the pumps, and the development work in the Pewabic amygdaloid at the bottom of its No. 1 shaft. The development work has been considered satisfactory, and according to the report of the company there is a considerable quantity of ore of an excellent grade available or developed when conditions warrant a renewal of production.

The Victoria Co. reduced its operating organization to one shift a day, which, according to the statement of the company, resulted in the maintenance of a high cost of production. The general reduction in the wage scale made in the district in January and February of 1919 was also made by this company, which, along with the others, restored the previous scale on August 1, 1919. The yield of copper from the ore was about 14 pounds to the ton for the year 1919, which was somewhat less than for the year 1918. Considerable development work was carried on during the year, part of which was considered unsatisfactory, and further operation in that part of the mine was temporarily suspended; some of the new ground developed, however, is reported to be promising.

On account of the high cost of labor the Keweenaw Copper Co. did not attempt any exploratory work on its lands during the year.

The Algomah Mining Co. did not conduct any operations of note during the year, the Lake Adventure and South Lake mines still being idle, awaiting improved working conditions.

MONTANA.

The first recorded production of copper from Montana ores was made in 1868. It was not until 1880, however, that a large production was made, but since that time Montana has been an increasingly important producer. It has made a greater total production than any other State, and by the end of 1919 it had furnished 27.59 per cent of the total output of the United States. Practically all this total output has been derived from the Butte district. Three smelting plants operated in 1919, the East Butte Mining Co.'s plant at Butte and the Anaconda Copper Mining Co.'s plants at Anaconda and Great Falls.

Butte district.—The year 1919 included, the Butte district has produced 7,790,651,000 pounds of copper, or 27.44 per cent of the total domestic production. The district ranks first in the United States in total production.

The district has unfortunately experienced more labor difficulties than any other copper-mining district in the United States, and the

cost of labor has increased more rapidly in this district than in any other The district has been handicapped for some time by its unfortunate labor situation. A large part of the labor of the district has been discontented, undesirable, and inefficient. In 1919 the situation was particularly bad because of labor shortage, strikes, and inefficiency. These difficulties led to the formation of a central labor bureau through which all the labor in the district is hired and whose function is to eliminate through investigation of previous records all undesirable elements.

The years 1919 and 1920 were marked by a great decline in production, by the closing of a number of less important mines, and by great reduction in smelting operations. In common with many other districts, by the time of the conclusion of hostilities great inroads into the developed reserves had been made and the development of further reserves was essential. In 1919 all companies devoted themselves very largely to development work, and some of the results are important enough to merit mention. High-grade ore was encountered at 3,860 feet in the main shaft of the Stewart mine. This ore is all primary sulphides, and the vein evidently belongs to one of the vein systems that have been so productive in the upper levels. The discovery of high-grade ore at this depth promises a long period of continued production.

The principal companies in the district are the Anaconda Copper Mining Co., North Butte Mining Co., the East Butte Copper Mining Co., the Davis-Daly Copper Co., and the Tuolumne Copper Mining Co.

Copper and associated metals produced in Butte district, Mont., 1906–1919.

Year.	Copper.	Average yield in copper.	Gold.	Silver.	Year.	Copper.	Average yield in copper.	Gold.	Silver.
	Pounds.	*Per cent.*	*Ounces per ton.*	*Ounces per ton.*		*Pounds.*	*Per cent.*	*Ounces per ton.*	*Ounces. per ton.*
1906	294,000,000	3.15	0.01	2.0	1913	283,600,000	2.70	0.0058	1.92
1907	222,000,000	2.75	.014	2.3	1914	235,700,000	2.66	.0059	1.83
1908	252,500,000	3.3	.0075	2.16	1915	267,000,000	2.66	.0066	1.82
1909	314,000,000	3.08	.0076	2.07	1916	349,500,000	2.81	.0059	1.79
1910	282,500,000	3.13	.0068	2.02	1917	270,500,000	2.81	.0056	1.84
1911	271,200,000	3.17	.0071	2.20	1918	321,104,000	2.17	.0059	2.03
1912	308,000,000	3.02	.0065	2.09	1919	169,051,000	2.16	.0071	2.69

Copper, gold, and silver produced by Anaconda Copper Mining Co. from company ores, 1913–1919.

Year.	Ore treated.	Copper.	Silver.	Gold.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	
1913	4,566,451	241,983,323	8,719,132	64,898	$12,997,500
1914	3,768,640	205,298,531	7,221,815	99,651	9,077,500
1915	4,258,129	235,076,289	8,064,986	106,702	9,325,000
1916	5,273,066	307,395,092	10,790,705	92,099	17,484,375
1917	3,906,901	239,014,880	8,368,180	58,545	19,815,625
1918	4,350,446	272,923,031	10,076,748	64,318	.....
1919	1,794,358	129,781,031	6,744,262	42,526	9,325,000

The annual report of the Anaconda Co. for 1919 states that

The mines of the company produced during the year 2,103,098.71 tons of ore and 10,420.67 tons of precipitates, a total of 2,113, 519.38 tons.

The copper reduction works treated for all companies during the year 2,340,100 tons of ore and other cupriferous material at Anaconda. No copper ores were treated at Great Falls, except a small quantity of copper concentrates from Anaconda used for the fluxing of the zinc plant residue. Of the total quantity 1,794,358 tons of ore were produced by company mines, 511,847 tons of ore were either purchased from or treated for other companies, and 33,895 tons of precipitates and cleanings from the old works at Anaconda and Butte were treated.

At Anaconda there were produced 144,112,285 pounds of fine copper, 7,377,476.85 ounces of silver, and 42,525.781 ounces of gold.

Of this production, 129,781,031 pounds of fine copper, 6,744,262.03 ounces of silver, and 42,525.781 ounces of gold were produced for your company.

The electrolytic copper refinery at Great Falls produced during the year 129,022,057 pounds of cathodes, 121,338,737 pounds of which were melted into shapes at Great Falls.

The copper leaching plant at Anaconda treated during the year 184,700 tons of tailings and 61,400 tons of purchased ore, from which there were produced 2,500 tons of cement copper.

The copper concentrator also treated by flotation 44,500 tons of slimes from the ponds and 31,000 tons of tailings.

Copper, silver, and gold produced by North Butte Mining Co., 1912–1919.

Year.	Copper ore and precipitates treated.	Copper.	Silver.	Gold.	Dividends.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	
1912	425,297	26,480,123	1,377,468	1,367	$697,000
1913	455,029	28,318,321	1,602,163	1,567	820,000
1914	337,415	18,421,761	1,092,300	1,107	635,000
1915	378,161	19,235,285	940,631	1,121	387,000
1916	544,456	24,498,181	1,047,063	1,712	1,075,000
1917	296,773	14,493,452	662,845	959	1,075,000
1918	453,356	20,680,695	891,157	1,375	430,000
1919	287,800	14,331,254	633,215	914	.....

The average cost to the North Butte Mining Co. of producing copper for the year 1919 was 14.85 cents a pound.

Copper produced by East Butte Copper Mining Co., 1912–1919.

Year.	Ore mined.	Average copper content.	Copper produced by smelter.	Average cost per pound of copper.
	Short tons.	*Per cent.*	*Pounds.*	*Cents.*
1912	99,458	5.78	14,709,460	9.698
1913	105,071	5.16	14,401,108	11.040
1914	72,853	4.72	9,175,578	11.110
1915	150,911	4.28	12,542,058	11.853
1916	258,899	3.67	18,340,713	16.887
1917	189,473	4.31	20,013,900	17.672
1918	184,493	4.25	24,599,890	19.712
1919	146,542	3.71	19,987,733	16.582

Exploratory work for 1919 developed ore estimated to be somewhat in excess of the quantity mined and removed during the year. Of the new ore developed, however, the proportion of first-class ore is materially less than the proportion of first-class ore mined during the year.

Operations of East Butte Copper Mining Co. for 1919.

Ore mined (wet weight).....	short tons..	146,542
Average assay value.....	per cent..	3.71
Cost of mining per ton, including development.....		$6.14
Company ore treated (dry weight).....	short tons..	143,654
Customs ore treated (dry weight).....	do....	79,818
Total ore treated.....	do..	223,472
Copper produced.....	pounds..	19,987,733
Silver produced.....	ounces..	698,146
Gold produced.....	do....	1,013
Gross value of metals shipped.....		$4,152,215.55
Other income.....		190,174.54
Gross income from operations.....		4,342,390.09
Cost of mining, treatment, freight, selling, refining, and cost of custom ore purchased.....	$3,662,676.68	
Miscellaneous operations.....	7,385.43	
		3,670,062.11
		672,327.98
Less depreciation.....	$5,921.99	
Ore depletion.....	3,442.80	
		9,364.79
		662,963.19
Less exploration and development.....		138,775.16
Net surplus on operations.....		524,188.03
Copper produced.....	pounds..	19,987,733
Price per pound received, New York.....	cents..	18.6856
Cost of production per pound.....	do....	16.5821
Profit per pound.....	do....	2.1035
Average price per ounce received for silver, New York..		$1.21486
Price per ounce received for gold, New York.....		$20.00

The main production for the year from the mines of the Tuolumne Copper Mining Co. was from the Main Range mine, which produced 26,515 dry tons of ore, averaging 2.094 per cent of copper, and 8.128 ounces of silver, and 0.0075 ounce of gold per ton.

NEVADA.

Nevada made its first recorded production of copper in 1873 but did not become an important factor in the industry until the porphyries of the Ely district began to produce. The production in 1919 was 64,683,734 pounds of copper, which represents 5.03 per cent of the total production in the United States. Inclusive of 1919 the total production in Nevada has been 886,798,996 pounds, which represents 3.12 per cent of the total production of the United States since 1845.

Most of the production has come from two districts, the Ely and the Yerington, of which the former is by far the more important.

Ely district.—The mines of the Ely district experienced the general troubles of the industry. The Nevada Consolidated Copper Co. reduced its output by one-half and carried on some exploration but no development work. Labor troubles arose, and operations were discontinued throughout August, 1919, on account of the strike that followed. The continued unsatisfactory condition of the

industry has been the cause of the continued reduced output. The concentrating and smelting plants were operated at only 50 per cent of their capacity, and the strike in August caused an additional loss of one month's time to the smelter.

Smelter production of metals in Ely (Robinson) district, Nev., 1908–1919.

Year.	Ore.	Copper produced.	Average yield in copper.	Gold and silver per ton of ore.
	Short tons.	*Pounds.*	*Per cent.*	*Cents.*
1908	429,925	14,776,363	1.72	24
1909	1,671,225	51,700,000	1.72	24
1910	2,346,354	62,332,419	1.30	21
1911	2,745,524	65,262,796	1.19	17
1912	2,985,217	64,932,446	1.09	17
1913	3,419,178	69,950,850	1.02	13.4
1914	2,749,913	51,089,921	.93	16
1915	3,204,374	64,638,158	1.01	19
1916	4,053,526	93,037,587	1.14	20
1917	4,466,017	93,615,335	1.05	18
1918	4,519,445	92,396,638	1.02	24
1919	2,273,961	[a] 47,871,048	1.05	17

[a] Mine production.

Metals produced by Nevada Consolidated Copper Co., 1909–1919.

Year.	Ore treated.	Average assay of copper.	Average extraction of copper.	Gold and silver recovered per ton.	Refined copper produced.	Average cost of copper per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Cents.*	*Pounds.*	*Cents.*	
1909	1,065,385	2.34	70.73	23.12	34,527,823	7.14	
1910	2,237,028	2.06	69.59	21.14	60,513,009	7.37	$2,982,644
1911	3,338,242	1.80	67.59	17.35	78,541,270	7.17	3,746,895
1912	2,852,515	1.692	68.25	16.48	63,063,261	8.86	2,999,137
1913	3,139,137	1.599	68.52	12.32	64,972,829	9.99	2,999,185
1914	2,640,294	1.483	68.48	13.45	49,244,056	10.16	2,249,389
1915	3,081,520	1.54	70.18	18.56	62,726,651	8.67	2,999,185
1916	3,922,634	1.632	73.87	20.44	90,735,287	10.17	7,497,963
1917	4,064,095	1.462	73.08	.....	82,040,508	12.45	8,297,746
1918	3,999,526	1.506	69.95	.....	76,607,062	17.98	6,498,235
1919	2,135,425	1.599	70.49	.....	43,971,892	18.65	2,999,186

Ore reserves of the Nevada Consolidated Copper Co., Dec. 31, 1919.

	Ruth.		Eureka.		Total.	
	Quantity (short tons).	Per cent of copper.	Quantity (short tons).	Per cent of copper.	Quantity (short tons).	Per cent of copper.
Total ore developed to Dec. 31, 1918	15,689,768	2.22	82,700,457	1.468	98,390,225	1.580
Total ore milled to Dec. 31, 1919	3,699,036	1.994	28,276,970	1.568	31,976,006	1.617
Recoverable ore remaining Dec. 31, 1919	11,990,732	2.24	54,423,487	1.418	66,414,219	1.563

The reserves are exclusive of the carbonate ores mined and held in stock and of the ore partly blocked out in the Kimberly, Wedge, and Veteran groups. Developed ore in these claims aggregates about 800,000 tons of 2.4 per cent copper.

The Consolidated Coppermines Co., which is engaged principally in the mining of the replacement ore bodies in the limestone along the porphyry contact, also greatly reduced its operations in 1919, and in 1920 the production was confined almost entirely to that made by lessees. Very satisfactory and encouraging results are reported to have attended the development work in the Alpha mine in 1919, and the results of development at the Taylor mine are also considered promising.

Ore mined, grade of ore, and metal produced by the Consolidated Coppermines Co. in 1919.

Mine.	Ore, dry weight.	Copper produced.	Gold produced.	Silver produced.	Lead produced.	Zinc produced.	Manganese produced.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Morris-Brooks	17,552	471,605	276.733	555.96			
Alpha	13,753	2,044,634	5.007	110.59			
Ora	80,013	1,315,255	563.181	1,425.60			
Leases	4,344	66,440	45.124	2,481.04	53,643	3,473,269	27,071
	115,662	3,897,934	890.045	4,573.19	53,643	3,473,269	27,071

The Kimberly concentrator was operated during only a portion of the month of January, 1919. Results were as follows:

Ore milled	short tons	17,552
Concentrates produced	do	959
Ratio of concentration, 18.3 into 1.		
Grade of ore	per cent of copper	1.44
Grade of concentrates	do	21.0
Recovery	per cent	86.2

Concentrating results at Steptoe mill of Nevada Consolidated Copper Co. on Consolidated Coppermines Co.'s Ora mine's ores treated.

Ore milled	short tons	80,013
Concentrates produced	do	6,735
Ratio of concentration, 11.88 into 1.		
Grade of ore	per cent of copper	1.385
Grade of concentrates	do	10.278
Recovery	per cent	62.49

Ore reserves of the Consolidated Coppermines Co. at the end of 1919.

	Quantity (short tons).	Per cent of copper.
Fully developed disseminated sulphide porphyry ore	9,870,135	1.41
Partly developed disseminated sulphide porphyry ore	9,659,000	1.25
	19,529,135	1.33
Heavy sulphide ore	200,000	3.00
Alpha oxidized ore	500,000	7.00

Yerington district.—The Yerington district is in Lyon County about 50 miles southwest of Reno and includes the productive area of copper mineralization in the Singatse Range, a low desert range which lies between Mason and Smith Valley. The Mason Valley Mines Co., the Bluestone Mining & Smelting Co., and the Nevada-Douglas Consolidated Copper Co. are the principal operators. The production by all operators was greatly reduced in 1919, and the year was devoted almost entirely to development work.

Copper produced in Yerington district, Nev., 1912–1919.

	Pounds.		Pounds.
1912	14,700,000	1916	3,491,000
1913	14,400,000	1917	19,396,000
1914	7,480,000	1918	17,139,000
1915	700,000	1919	3,077,000

NEW MEXICO.

The production of blister copper from New Mexico in 1919 was 60,377,320 pounds, compared with 96,559,580 pounds in 1918.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. During the nineteenth century, however, there was but small output. A little copper was reported for the year 1858, but New Mexico did not have a steady output until after 1880, and did not become a large producer until 1912.

From 1845 to 1919 New Mexico had a recorded output of 645,966,735 pounds of copper, or 2.28 per cent of the total output of the country. The principal producing districts are those of Grant County.

Santa Rita district.—The Santa Rita district was probably the first district in the West in which there was any notable production of copper; the output began in the closing years of the eighteenth century, and the metal went to Mexico for coinage. There are no accurate records of the production for this early period of operation.

From the best sources available it is estimated that the total production of copper to the end of 1919 has been 573,245,000 pounds.

Copper produced in Santa Rita district, N. Mex., 1906–1919.

	Pounds.		Pounds.		Pounds.
1906	3,075,000	1911	1,400,000	1916	74,228,000
1907	5,000,000	1912	25,000,000	1917	82,200,000
1908	4,000,000	1913	50,511,000	1918	77,547,000
1909	3,000,000	1914	54,000,000	1919	40,359,000
1910	2,670,000	1915	65,000,000		

The Chino Copper Co. began producing late in 1911.

Metals produced by Chino Copper Co., N. Mex., 1911–1919.

Year.	Ore milled.	Copper content.	Mill recovery.	Production of refined copper.	Gold and silver per ton.	Cost of copper per pound.	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	*Cents.*	
1911	.....	.....	.....	986,375	.....	.....	.....
1912	1,120,375	2.077	61.63	27,776,088	.....	7.69	.....
1913	1,942,700	2.033	67.31	50,511,661	.....	8.78	$1,919,070
1914	1,907,300	2.115	67.858	53,999,928	2.71	7.60	2,169,065
1915	2,379,800	2.155	66.588	64,887,788	3.35	7.12	2,609,860
1916	3,094,400	1.83	66.59	72,319,508	2.60	8.70	7,177,335
1917	3,608,100	1.64	69.32	79,636,235	1.59	11.39	8,612,802
1918	3,836,400	1.63	63.275	75,655,641	1.09	17.178	[a] 3,914,910
1919	1,765,200	1.82	65.67	40,488,706	2.16	[b] 15.53	[c] 2,609,940

[a] $1,087,475 represents distribution of capital.
[b] Represents cost exclusive of Federal tax, comparative cost per pound for 1918 was 14.13.
[c] Total represents distribution of capital, no dividends paid during 1919.

Burro Mountain district.—The Burro Mountain district, southwest of Silver City, produced about 6,101,000 pounds of copper in 1919. The total production from the district has probably been about 57,567,000 pounds.

The net production from the mines of the Burro Mountain Copper Co. was 5,678,386 pounds of copper and 13,613 ounces of silver.

Metals produced by Burro Mountain Copper Co., N. Mex., 1919.

	Quantity (dry weight).	Per cent of copper.	Copper produced.	Silver produced.
	Short tons.		*Pounds.*	*Ounces.*
Concentrates	18,965	14.869	5,400,776	13,219.21
Precipitates	100	42.700	82,058	13.20
	19,065	.....	5,482,834	13,232.41
Leased ore	1,926	5.300	195,552	380.80
	20,991	.....	5,678,386	13,613.21

Operations of the concentrator of the Burro Mountain Copper Co., N. Mex., 1919.

Ore milled	short tons	184,946
Average assay	per cent of copper	2.087
Concentrates produced	short tons	18,965
Average assay	per cent of copper	14.869
Tailings produced	short tons	165,981
Average assay	per cent of copper	.627
Saving (average of four methods of figuring)	per cent	73.042
Ratio of concentration		9.752
Ore milled per day, actual running time	short tons	1,448.512
Kilowatt hours per ton of ore milled		12.829

These statistics show a few improvements, but in general the work of the five months' period during which the mill was operated was a continuation of what has been done heretofore.

Lordsburg district.—The Lordsburg district, in central Grant County, has been a steady producer of copper for several years. The Eighty Five Mining Co. was the largest producer.

Copper produced in Lordsburg district, N. Mex., 1906–1919.

[Mine figures.]

	Pounds.		Pounds.		Pounds.
1906	213,000	1911	2,455,000	1916	4,755,000
1907	463,000	1912	3,156,000	1917	4,262,000
1908	259,000	1913	1,601,000	1918	2,215,000
1909	590,000	1914	2,615,000	1919	3,516,000
1910	1,628,000	1915	3,890,000		

TENNESSEE.

The production of blister copper in Tennessee in 1919 was 15,629,454 pounds, compared with 15,053,568 pounds in 1918.

The entire output came from the Ducktown district, in the extreme southeastern part of the State, in Polk County. The district was one of the earliest large producers in the country. Operations began about 1850, and from that date till the end of the Civil War there was a large production from the "black copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters were shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has

been a steady producer from the primary sulphide ores. To the end of 1919 the total output of the district has been 366,741,000 pounds.

Metals produced in Ducktown district, Tenn., 1906–1919.

[Smelter figures.]

Year.	Ore treated.	Copper produced.	Average yield of copper.	Gold and silver per ton of ore.
	Short tons.	*Pounds.*	*Per cent.*	*Cents.*
1906	538,141	17,809,442	1.7	8
1907	558,487	19,475,119	1.77	7
1908	618,806	19,710,103	1.55	5
1909	576,680	19,207,747	1.66	6
1910	552,796	16,691,777	1.52	8
1911	581,974	19,965,143	1.62	11.7
1912	603,229	18,395,256	1.53	10.5
1913	652,253	19,489,654	1.476	11.2
1914	653,621	18,661,112	1.435	9
1915	623,534	18,205,308	1.45	9
1916	482,495	14,556,278	1.52	14
1917	589,004	16,093,757	1.37	15
1918	529,012	15,053,568	1.42	18
1919	555,018	15,629,454	1.41	21

A part of the copper has been marketed without refining and without recovering the gold and silver contained. This accounts in large part for the variation in the gold and silver recovered per ton of ore treated.

The fact that the ores can be extracted with little timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor have made it possible to mine and treat these low-grade ores at a profit.

The pyritic process of smelting is practiced successfully by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper & Chemical Corporation. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

Sulphuric acid plants are operated by both companies. The successful operation of these plants has not only helped to solve the troublesome smelter-smoke problem but has added very materially to the revenue of the companies.

The companies of the district are limited in their output of copper by the fact that some sulphur fumes necessarily escape into the air, and the volume that may be permitted to escape is limited by order of the courts.

Copper and sulphuric acid produced by Tennessee Copper & Chemical Corporation, 1911–1919.

Year.	Ore smelted.	Copper.	Sulphuric acid 60° Baumé.	Cost of copper per pound.	Dividends.
	Short tons.	*Pounds.*	*Short tons.*	*Cents.*	
1911	436,285	13,808,940	.....	10.88	$300,000
1912	444,289	13,252,634	192,084	11.00	500,000
1913	470,135	13,493,140	197,712	11.34	750,000
1914	485,051	12,871,113	210,163	11.84	600,000
1915	475,301	12,750,418	210,666	10.53	600,000
1916	385,188	9,404,295	181,637	14.36	150,000
1917	457,902	10,547,708	262,857	14.90	.....
1918	402,071	9,819,838	283,092	18.526	392,817
1919	413,877	10,414,815	266,627	18.715	.....

The company's reserves of ore in the Burra Burra, London, and Polk County mines at the end of 1919 were estimated at 3,512,556 tons.

In July, 1919, the Ducktown Sulphur, Copper & Iron Co. reported developed ore reserves in the Mary mine as 1,500,000 tons and low-grade ore in the Isabella mine as 2,500,000 tons and in the Cherokee mine as 1,000,000 tons.

A process is being worked out for the treatment of the company's low-grade ore which it is expected will result in doubling the output of copper.

The district is served by a branch line of the Louisville & Nashville Railroad, with which the mines and smelters of the companies are connected by private line.

UTAH.

Utah produced copper in 1870, but the production was not large until 1900, which marks the beginning of production from the disseminated deposits in monzonite porphyry. Since that time the industry has been rapidly and steadily growing. The total copper production from the State to the end of 1919 amounts to 2,252,373,254 pounds, or 7.93 per cent of the total domestic production since 1845. The production in 1919 was 143,836,304 pounds. The decrease from the production of 1918 was due to the same general conditions in the copper-mining industry that occasioned the great decrease in all the copper-mining States. The State ranks fourth in total production and fourth in production for 1919. There are two copper smelting plants operating in the State—the Garfield smelter, at Garfield, and the International smelter, at Tooele. The largest output is derived from the great disseminated deposits at Bingham, although the vein and replacement deposits of the Bingham, Tintic, Beaver, and Clifton districts make an important production.

Bingham district.—The discovery of copper mineralization in Bingham Canyon was early in the history of mining in the State, but until 1896 the mining in the district was confined entirely to gold, silver, and lead. In 1896 copper mining was first undertaken, and in 1904 the Utah Copper Co. began its production from its disseminated deposits in the district. Inclusive of 1919, the district has produced approximately 1,926,410,000 pounds of copper, or 6.78 per cent of the total production of the country since 1845. In 1919 the production decreased to 116,697,000 pounds, or 9.63 per cent of the total production of the United States for the same year. The district ranks fourth in total production and fifth in output for 1919.

Copper produced (mines report) in Bingham district, Utah, 1906–1919.

	Pounds.		Pounds.		Pounds.
1906	39,424,000	1911	129,996,000	1916	223,620,000
1907	45,432,000	1912	116,622,000	1917	225,412,000
1908	71,156,000	1913	144,920,000	1918	211,195,000
1909	92,560,000	1914	141,925,000	1919	116,697,000
1910	113,726,000	1915	176,593,000		

The Utah Copper Co. is by far the largest producer in the district and in the State, and the result of its operations for the year are shown in the following tables:

Metals produced by Utah Copper Co. from ore milled, 1911–1919.

Year.	Ore milled.	Copper content.	Mill recovery.	Copper.[a]	Gold and silver per pound of copper.	Net cost per pound of copper.[b]	Dividends.
	Short tons.	*Per cent.*	*Per cent.*	*Pounds.*	*Cents.*	*Cents.*	
1911	4,680,801	1.51	69.53	93,514,419	1.07	7.865	$4,703,022
1912	5,315,321	1.36	66.32	91,366,337	.96	8.781	4,729,747
1913	7,519,392	1.25	63.95	113,942,834	.64	8.647	4,747,710
1914	6,470,166	1.42	66.04	115,690,445	.76	7.245	4,827,885
1915	8,494,300	1.43	64.13	148,397,006	.62	6.61	6,904,082
1916	10,994,000	1.44	62.34	187,531,824	.65	6.92	19,493,880
1917	12,542,000	1.337	61.10	195,837,111	.70	10.95	[c] 23,555,105
1918	12,160,700	1.226	65.11	188,092,405	.79	14.53	[d] 16,244,900
1919	5,538,700	1.26	78.46	105,088,740	.83	12.366	[e] 9,746,940

[a] Net production, not copper content of concentrates.
[b] Value of precious metals and railway earnings deducted.
[c] Includes $2,842,857 capital distribution.
[d] Includes $3,655,102.50 capital distribution.
[e] Includes $7,797,552 capital distribution.

Costs of mining, milling, and concentrating copper ore by Utah Copper Co., 1910–1919.

Year.	Ore.	Cost per ton.			
		Mining.	Transportation.	Milling.	Total.
	Short tons.				
1910	4,340,245	$0.4097	$0.2978	$0.4663	$1.1738
1911	4,680,801	.4479	.3078	.4168	1.1725
1912	5,315,321	.4233	.2848	.4158	1.1239
1913	7,519,392	.3288	.2797	.3676	.9761
1914	6,470,166	.3232	.2782	.3536	.9550
1915	8,494,300	.2441	.2781	.3402	.8624
1916	10,994,000	.2781	.2792	.3782	.9355
1917	12,542,000	.4446	.2794	.6930	1.4170
1918	12,160,700	.5370	.2983	.9277	1.7630
1919	5,538,700	.4900	.3040	1.2062	2.0002

On account of the unfortunate condition of the copper market in 1919 operations were reduced by this company to 50 per cent of normal. The Magna mill was closed early in the year, and the Arthur plant milled all the ore mined by the company during 1919. Development work was carried on throughout the year, and the results of this work, together with the results of routine developments incidental to operations, have proved additional ore, which, according to the company's statement, considerably more than balances the ore extracted during the year. From previous calculations, after deduction of the ore mined during 1919, the total ore reserves, exclusive of the ore represented by the uncalculated developments, amounted at the end of the year to 368,501,300 tons, averaging about 1.37 per cent of copper. Stripping operations were carried on throughout the year, and 2,062,911 cubic yards of cap rock was removed, which makes a total of 50,105,735 cubic yards since the development of the deposit was undertaken. The stripping operations until January 1, 1920, covered a total area of 261.26 acres, of which 137.87 acres was entirely stripped. During the year 5,538,700 tons of concentrating ore was mined by steam shovels, a total of 84,920,100 tons of ore, averaging 1.39 per cent of copper, since steam-shovel mining was begun. A small quantity (492 tons) of ore was mined by underground methods from the sulphide mine and shipped direct to the smelter. In addi-

tion to the development work considerable improvements were made in the mills and much old equipment was replaced with new.

The usual labor troubles affected operations somewhat, but to a less extent than in many other districts. In addition to the curtailment of production to a 50 per cent basis, plants and equipment were maintained in readiness to resume normal operations and, although the working organization suffered serious depletion from labor troubles and the reduction in operations, more or less successful effort was made to maintain the nucleus of the organization around which the full mining complement could be recruited easily and readily when conditions warranted.

In spite of the increased costs of labor and material the average cost—notably in mining—was considerably reduced and the recovery by the mills was considerably increased, probably owing to the fact that the mills were not so nearly taxed to capacity as they were in 1918.

The net operating profit decreased from $13,807,302.65 in 1918 to $4,689,872.15 in 1919; this is exclusive of income derived from dividends on investments and other sources of income foreign to the actual mining operations of the company.

The Utah Consolidated Copper Co. is the next largest producer in the district, as is shown by the results of its operations given in the following table:

Copper, gold, and silver produced by Utah Consolidated Mining Co., 1911–1919.

Year.	Ore.	Copper content.	Copper.[a]	Gold per ton.	Silver per ton.	Dividends.
	Short tons.	*Per cent.*	*Pounds.*	*Ounces.*	*Ounces.*	
1911	162,522	2.891	9,162,023	0.0936	0.9815	$150,000
1912	159,143	2.146	6,506,814	.077	.828	450,000
1913	181,077	1.987	7,710,668	.056	705	450,000
1914	153,345	2.509	7,584,391	.085	.996	600,000
1915	207,119	2.22	8,836,091	.075	1.02	600,000
1916	360,034	1.734	12,211,118	.052	.796	1,125,000
1917	226,536	1.797	7,968,165	.050	.764	1,050,000
1918	221,651	2.03	8,476,197	.054	.82	450,000
1919	126,893	2.22	5,710,346	.07	1.27	.....

[a] Includes copper derived from lead ores.

Production was curtailed, and the company devoted itself largely to development work and mill experimentation, which determined that a large part of the ore that had been previously considered too low in grade to work could be successfully concentrated by flotation. Plans are being completed for the construction of a 1,000-ton flotation plant to concentrate such ore. Another feature was the final decision in 1920 in the suit between the Utah Consolidated and the Utah Apex companies in a controversy over Apex rights to important ore bodies. This suit, which was of national interest and importance in the interpretation of what constitutes a lode, was decided in favor of the Utah Apex Mining Co., which gained or retained title to all but one of the disputed ore bodies.

The Bingham Mines Co. operated its Dalton and Lark group of mines during the year, with the results shown below:

Copper, lead, gold, and silver produced by the Bingham Mines Co. from the Dalton and Lark mines in 1919.

	Ore.		Copper.	Lead.	Gold.	Silver.
	Wet tons.	*Dry tons.*	*Pounds.*	*Pounds.*	*Ounces.*	*Ounces.*
Lead	422.520	400.622	9,993	82,955	17.282	3,506.23
Copper	22,647.283	21,994.564	484,374	.....	1,463.660	86,691.89
	23,069.803	22,395.186	494,367	82,955	1,480.942	90,198.12

The company experienced considerable difficulty in carrying on its development work owing to the scarcity of labor, but it plans, as soon as conditions will permit, to develop the ore bodies as fully as possible.

Tintic district.—The production of copper from the Tintic district is largely incidental to the production of other metals. The quantity of ore in which copper is the most valuable metal is very small. There has, however, been a small output of copper from the district for many years, but no dependable record of this early output is available. It is estimated that inclusive of 1919 the district has made a total production of 149,776,000 pounds of blister copper.

Copper produced (mines report) in Tintic district, Utah, 1906–1919.

	Pounds.		Pounds.		Pounds.
1906	7,322,000	1911	10,922,000	1916	7,107,000
1907	7,756,000	1912	13,339,000	1917	9,118,000
1908	5,708,000	1913	9,262,000	1918	6,569,000
1909	5,916,000	1914	5,290,000	1919	3,251,000
1910	8,994,000	1915	5,358,000		

Beaver district.—The first important production of copper from Beaver County was derived from the Horn Silver mine in 1889, and since that time a small production has been made from lead-silver ores and from small copper mines. The importance of the district as a producer of copper began with the completion of the Cactus mine mill in 1905. Inclusive of 1919 the district has yielded about 49,076,000 pounds of copper. The important producers in recent years have been the Cactus, Horn Silver, O K, Old Hickory, and Milford Copper. The tailings from the Cactus mill were treated by flotation.

Copper produced (mines report) in Beaver County, Utah, 1906–1919.

	Pounds.		Pounds.		Pounds.
1906	5,406,000	1911	3,739,000	1916	3,204,000
1907	5,640,000	1912	3,040,000	1917	3,702,000
1908	5,706,000	1913	3,137,000	1918	2,636,000
1909	1,246,000	1914	1,512,000	1919	539,000
1910	1,128,000	1915	429,000		

Clifton district.—By far the most important producer in the Clifton district is the Western Utah Copper Co.

Other districts.—Some copper has been produced in other districts from lead-silver ores, but they are not of great consequence as producers of copper.

OTHER STATES.

Georgia.—In 1919 Georgia produced 8,306 pounds of copper, as compared with 397,078 pounds in 1918. The productive area is adjacent to the Ducktown copper district, Tenn.

Oregon.—Oregon produced 2,808,017 pounds of blister copper in 1919, compared with 2,630,499 pounds in 1918. To the end of 1919 the State has a recorded output of 12,745,649 pounds of copper.

Vermont.—Vermont produced 582,561 pounds of blister copper, a decrease of 314,069 pounds from the output in 1918.

Washington.—Washington produced 2,552,134 pounds of blister copper, as compared with 2,330,568 pounds in 1918.

Wyoming.—The production from Wyoming amounted to 150,051 pounds of blister copper as compared with 866,698 pounds in 1918.

REFINERY PRODUCTION.

The refinery output of copper in the United States in 1919 was made by 12 plants, 9 of which employed the electrolytic method and 4 employed the furnace process on Lake Superior copper, the Calumet & Hecla plant employing both methods. Six of the large electrolytic refineries are on the Atlantic tidewater, and four Lake refineries are on the Great Lakes. Only two plants are located west of the Great Lakes—one at Great Falls, Mont., and one at Tacoma, Wash. In addition to these refineries there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper. The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

CASTING AND PIG COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries so small a content of precious metals that, together with the added value of electrolytic copper, it will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is small. Some blister or pig copper low in precious metals has been exported without further treatment and is probably consumed without electrolytic refining. A large percentage of the pig and casting copper shown in the table is from Arizona. Some of the districts produce a rather high grade of blister copper carrying a small amount of precious metals, and it is found profitable to market some of it without electrolytic refining. During 1919 the production of furnace-refined new casting copper amounted to 18,223,145 pounds and of unrefined pig and best select copper to 3,674,191 pounds.

LAKE COPPER.

By Lake copper, as the term is used in this report, is meant the output of the Lake smelters. A considerable portion of this output is refined electrolytically, but most of the electrolytically refined

Lake copper is mixed with furnace-refined copper or is sold as some brand of Lake copper. Of the 177,594,135 pounds of copper produced by the Lake smelters, about 36,000,000 pounds was refined electrolytically, either to free the copper from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

Under electrolytic copper, in the table on page 594, is included all new copper that was refined electrolytically, except that from the Lake district that was marketed as Lake copper. In 1919 the production of electrolytic copper from primary materials of domestic origin amounted to approximately 1,233,994,000 pounds, and from materials of foreign origin to 370,559,000 pounds, and in addition 32,409,000 pounds was produced from secondary sources—a total of electrolytic production of 1,636,962,000 pounds for the year.

SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. A canvass of plants producing secondary copper has been made by J. P. Dunlop, of the United States Geological Survey. Concerning the output of secondary copper Dunlop[1] says:

> The total quantity of secondary copper recovered in 1919, on the assumption that the brass remelted had an average copper content of 70 per cent, was 287,190 short tons, of which 35,643 tons (13,797 tons more than in 1918) was recovered by plants refining primary metals and the remainder by plants treating only secondary materials. The copper produced by smelters of the latter class includes 48,087 tons of pig copper, 28,670 tons of copper in alloys other than brass, and 174,790 tons of copper in remelted brass. These figures indicate a decrease for 1919 of about 18,200 tons of pig copper, of 55,370 tons of copper in brass, and of about 5,710 tons in alloys other than brass. At least 134,500 tons was recovered from clean scrap made in the course of manufacture of copper and brass ware, so that less than 152,600 tons was obtained from ashes, cinders, and scrap, or from material that had actually been used and discarded. From the reports received it is quite evident that there was a decrease in the quantity of old copper smelted and that there was a much larger decrease in the quantity of clean new copper and brass scrap remelted. The reports from munition factories show an enormous decrease in the quantity of clean scrap remelted, and there was a decrease reported in the quantity of scrap brass from other users. The quantity of scrap brass used amounted to 249,700 tons, and of this at least 143,700 tons was clean new punchings, filings, and clippings.
>
> The value of the copper, both as metal and in alloys, is computed at the average yearly price of 18.6 cents a pound, the average sales price of all marketable grades of new metal.
>
> According to the Bureau of Foreign and Domestic Commerce the exports for the calendar year 1919 of scrap brass and copper fit only for remanufacture were 661 tons of scrap brass and 225 tons of scrap copper, and the imports of scrap copper were 2,109 tons and of scrap brass 7,933 tons. Many railways sell or turn in the larger portion of their brass and copper scrap and other metal waste to dealers in part payment for new material, but the reports received show that the railways utilized in their own shops and foundries more than 16,000 tons of brass in addition to 960 tons of copper and 636 tons of copper in alloys other than brass. The railway reports, however, frequently include alloys termed "brass," which should more properly be designated "bronze." Some other alloys of copper are known by names that do not typify the metals alloyed.

[1] Dunlop, J. P., Secondary metals: U. S. Geol. Survey Mineral Resources, 1919, pt. 1, pp. 62–68, 1921.

Secondary copper, 1919.

	Short tons.
Copper as metal	83,730
Copper in alloys other than brass	28,670
	112,400
From new scrap	34,000
From old scrap	78,400
	112,400
Brass scrap melted:	
New clean scrap	143,700
Old scrap	106,000
	249,700
Copper content of brass scrap (averaging about 70 per cent copper):	
New scrap	100,590
Old scrap	74,200
	174,790
Total copper produced from secondary sources:	
From new scrap	134,590
From old scrap	152,600
	287,190
Exports of scrap brass in 1919	661
Exports of scrap copper in 1919	225
Imports of scrap brass in 1919	7,933
Imports of scrap copper in 1919	2,109

REFINED COPPER.

The total output of new refined copper in 1919 was 1,805,000,000 pounds, a decrease of 627,000,000 pounds from that of 1918.

Primary and secondary copper produced by regular refining plants and imported in 1914–1919, in pounds.

	1914	1915	1916	1917	1918	1919
Primary:						
Domestic: [a]						
Electrolytic	991,573,073	1,114,345,342	1,579,620,513	1,452,744,593	1,560,327,422	1,233,994,324
Lake	158,009,748	[b]236,757,062	269,794,531	268,508,091	231,096,158	177,594,135
Casting	21,506,325	21,555,129	12,469,050	69,916,911	15,284,635	18,223,145
Pig and best select	39,334,043	15,047,990	26,868,105	82,376,576	76,165,976	3,674,191
	1,210,423,189	1,387,705,523	1,888,752,199	1,873,546,171	1,882,874,191	1,433,485,795
Foreign: [a]						
Electrolytic	323,358,205	246,498,925	370,635,116	[c]555,000,000	[c]492,181,364	[c]370,558,779
Casting and best select					57,329,735	1,262,227
	1,533,781,394	1,634,204,448	2,259,387,315	2,428,546,171	2,432,385,290	1,805,306,801
Secondary:						
Electrolytic	27,702,928	38,156,789	78,585,296	66,337,771	34,674,062	32,408,548
Casting	4,224,052	21,417,901	25,838,511	12,779,125	9,018,049	38,876,481
	31,926,980	59,574,690	104,423,807	79,116,896	43,692,111	71,285,029
Total output	1,565,708,374	1,693,779,138	2,363,811,122	2,507,663,067	2,476,077,401	1,876,591,830

[a] The separation of refined copper into metal of domestic and of foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.

[b] Some Lake copper was refined at seaboard plants and doubtless marketed under some brand other than Lake. This has been excluded from the Lake copper.

[c] Includes refined copper imported.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of about 503,095,000 pounds of copper as copper and in brass and other alloys of copper, a total production of 574,380,000 pounds from secondary sources. Of this total at least 269,180,000 pounds was produced by remelting clean scrap produced in the manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution from plants in the United States to the world's supply of copper for 1919 is found to be 2,380,000,000 pounds.

Refined copper produced in the United States, 1906–1919, in pounds.

Year.	From primary sources (domestic and foreign).				From secondary sources (copper and copper in alloys).
	Electrolytic.	Lake.	Casting and pig.	Total.	
1906	839,984,614	205,608,382	33,459,413	1,079,052,409	.....
1907	837,389,422	178,534,141	16,592,684	1,032,516,247	.....
1908	848,109,132	222,289,584	67,563,692	1,137,962,408	.....
1909	1,101,894,864	227,005,923	62,120,667	1,391,021,454	.....
1910	1,128,304,725	221,462,984	72,271,426	1,422,039,135	.....
1911	1,156,111,987	218,185,236	59,577,803	1,433,875,026	214,000,000
1912	1,274,935,371	231,112,228	62,056,879	1,568,104,478	275,000,000
1913	1,400,741,470	155,715,286	58,611,026	1,615,067,782	273,000,000
1914	1,314,931,278	158,009,748	60,840,368	1,533,781,394	255,764,000
1915	1,360,844,267	236,757,062	36,603,119	1,634,204,448	392,374,000
1916	1,950,255,629	269,794,531	39,337,155	2,259,387,315	700,000,000
1917	2,007,744,593	268,508,091	152,293,487	2,428,546,171	766,800,000
1918	2,052,508,786	231,096,158	148,780,346	2,432,385,290	705,340,000
1919	1,604,553,103	177,594,135	23,159,563	1,805,306,801	574,380,000

COPPER SULPHATE.

The production of hydrous copper sulphate or bluestone by the copper refineries of the United States in 1919 was 31,081,287 pounds, having a copper content of 7,883,000 pounds, compared with 31,292,490 pounds of bluestone, having a copper content of 7,917,000 pounds in 1918.

STOCKS.

Stocks of copper Jan. 1, 1906–1920, in pounds.

Year.	Refined copper.	Blister and material in process of refining.	Year.	Refined copper.	Blister and material in process of refining.
1906	118,224,028	110,000,144	1914	90,385,402	247,789,811
1907	46,497,181	135,310,239	1915	173,640,501	203,067,571
1908	125,745,796	175,254,659	1916	82,429,666	274,000,000
1909	121,876,759	234,013,843	1917	128,055,229	424,000,000
1910	141,486,244	266,754,808	1918	114,000,000	411,000,000
1911	122,803,656	245,218,530	1919	180,000,000	562,600,000
1912	88,372,195	219,864,749	1920	631,000,000	273,000,000
1913	105,497,683	274,072,084			

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1919 was 429,387,594 pounds, according to the records of the Bureau of Foreign and Domestic Commerce. The imports in 1918 were 575,805,115 pounds. The following tables show the character and source of copper-bearing materials imported during 1918 and 1919:

Copper imported into the United States in 1918 and 1919, by countries, in pounds.

[General imports.]

Country.	Ore (copper content).	Concentrates (copper content).	Matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined in bars, plates, rods, or other forms.	Old and clippings for remanufacture.	Composition metal, copper chief value.
1918.							
United Kingdom	39,220	.....	773,076	112,738	200	300	54,945
Spain	.....	.....	.....	.....	.....	.....	.....
Canada	30,060,903	870,066	787,821	37,881,986	4,951,617	935,112	39,210
Mexico	3,373,084	38,867,789	22,638,810	83,568,187	4,244,197	17,682	.....
Chile	14,707,473	.....	4,239,615	156,285,580	18,264,771	27,506	11,918
Cuba	23,861,119	4,761,704	94,080	.....	.....	550,164	56,347
Peru	1,200,879	.....	2,380,831	81,492,209	8,693,200	6,342	4,259
Japan	.....	.....	.....	827,404	336,022	.....	.....
Other countries	3,629,335	1,768,315	3,162,361	18,203,547	1,597,762	384,433	40,996
	76,872,013	46,267,874	34,076,594	378,371,651	38,087,769	1,921,539	207,675
1919.							
United Kingdom	.....	.....	201,706	228,083	224,000	.....	223,689
Spain	2,157,072	.....	.....	.....	.....	2,000	.....
Canada	24,487,478	1,608,378	2,105,357	31,199,467	1,860,609	3,612,020	22,412
Mexico	918,091	27,600,065	28,852,151	52,609,210	12,467,393	6,954	.....
Chile	7,636,963	1,456,571	6,407,432	89,859,898	20,449,718	.....	.....
Cuba	11,107,064	3,947,226	925,295	363	.....	362,898	11,061
Peru	1,165,768	.....	304,530	80,829,505	.....	16,799	.....
Japan	.....	.....	.....	600	.....	.....	.....
Other countries	2,244,075	1,800,840	1,529,001	8,493,323	137,040	216,669	98,820
	49,716,511	36,413,080	40,325,472	263,220,449	35,138,760	4,217,340	355,982

Copper (in unmanufactured form) imported into the United States, 1906–1919.

[General imports.]

	Pounds.		Pounds.		Pounds.
1906	225,593,281	1911	334,607,538	1916	462,335,980
1907	252,620,054	1912	410,241,295	1917	556,420,297
1908	218,705,487	1913	408,778,954	1918	575,805,115
1909	321,801,114	1914	306,350,827	1919	429,387,594
1910	344,435,771	1915	315,698,449		

EXPORTS.

The exports of metallic copper (exclusive of ore, concentrates, and composition metal) from the United States in 1919 amounted to 515,595,019 pounds, according to the Bureau of Foreign and Domestic Commerce. Exports of copper sulphate were 13,938,819 pounds in 1915, 19,469,565 pounds in 1916, 29,068,748 pounds in 1917, 14,477,339 pounds in 1918, and 9,140,673 pounds in 1919.

Metallic copper exported from the United States, 1906–1919.[1]

	Pounds.		Pounds.		Pounds.
1906	454, 752, 018	1911	786, 553, 208	1916	784, 006, 486
1907	508, 929, 401	1912	775, 000, 658	1917	1,125,647,336
1908	661, 876, 127	1913	926, 241, 092	1918	744, 243, 481
1909	682, 846, 726	1914	840, 080, 922	1919	515, 595, 019
1910	708, 316, 543	1915	681, 917, 855		

Copper sulphate (blue vitriol) exported from the United States, 1913–1919.

Year.	Quantity. (pounds).	Value.
1913	4, 168, 675	$211, 753
1914	7, 387, 226	327, 967
1915	13, 938, 819	680, 966
1916	19, 469, 565	2, 803, 833
1917	29, 068, 748	3, 038, 380
1918	14, 477, 339	1, 395, 946
1919	9, 140, 673	928, 291

Copper exported from the United States, 1917–1919, in pounds.

	1917	1918	1919
Ore (copper content)	5, 135, 818	2, 387, 275	507, 846
Concentrates (copper content)	821, 477	872, 564	160, 821
Unrefined black blister and converter copper (bars, pigs, and other forms)	16, 992, 357	14, 687, 823	1, 674, 411
Refined in ingots, bars, rods, or other forms	1, 030, 779, 328	690, 027, 891	438, 160, 818
Composition metal, copper chief value	[a] 1, 228, 032	186, 260	364, 089
Old and scrap	1, 070, 389	257, 403	449, 804
Pipes and tubes	[a] 7, 260, 833	4, 109, 226	5, 993, 959
Plates and sheets	42, 664, 931	19, 471, 584	13, 764, 425
Wire	26, 879, 498	15, 689, 554	55, 551, 602
	1, 132, 832, 663	747, 689, 580	516, 627, 775

[a] Figures cover six months' period beginning July 1, 1917.

The value of the copper exported is stated by the Bureau of Foreign and Domestic Commerce as $146,377,621 in 1913, $117,633,-145 in 1914, $117,703,941 in 1915, $206,163,241 in 1916, $338,723,756 in 1917,$195,840,637 in 1918, and $117,417,055 in 1919.

[1] Exclusive of ore, concentrates, and composition metal.

Copper exported from the United States, 1917–1919, by kind and destination, in pounds.

1917.

Destination.	Ore (copper content).	Concentrates, matte and regulus (copper content).	Unrefined black copper and copper in bars, pigs, or other forms.	Refined, in bars, plates, rods, or other forms.	Composition metal, copper chief value.	Old and scrap.	Pipes and tubes.	Plates and sheets.	Wire (except insulated).	Total.
United Kingdom			2,946,465	372,743,338		31,864	3,315,199	22,204,624	4,987,818	406,229,308
France			583,973	366,514,608	1,120,231		1,304,337	5,063,700	5,707,611	380,294,460
Italy			13,357,078	152,997,819		834,465	651,278	9,524,344	3,566,542	180,931,526
Netherlands				376,661			19,601	126,535	1,524,185	2,046,982
Russia in Europe				71,658,907			250			71,659,157
Other Europe				6,723,723			115,756	1,229,491	5,868,332	13,937,302
Canada	5,135,818	821,477	103,686	49,867,577	66,169	198,436	457,207	2,275,523	682,203	59,608,096
Japan				101,156			2,268	519	2,095	106,038
Other countries			1,155	9,795,539	41,632	5,624	1,394,937	2,240,195	4,540,712	18,019,794
	5,135,818	821,477	16,992,357	1,030,779,328	[a] 1,228,032	1,070,389	[a] 7,260,833	42,664,931	26,879,498	1,132,832,663

1918.

United Kingdom			1,619,082	251,805,814	11,200		13,267	4,757,767	669,557	258,876,687
France			3,932,967	265,270,793			942,487	4,547,080	3,627,392	278,320,719
Italy			8,632,917	121,907,864			610,790	4,948,479	1,785,466	137,885,516
Russia in Europe							15,437			15,437
Other Europe			448,000	16,082,357			214,566	455,975	4,434,916	21,635,814
Canada	2,387,275	872,564	52,247	33,087,082	68,803	256,071	373,757	1,579,979	549,095	39,226,873
Japan				33,075	24,809				33,204	91,088
Other countries			2,610	1,840,906	81,448	1,332	1,938,922	3,182,304	4,589,924	11,637,446
	2,387,275	872,564	14,687,823	690,027,891	186,260	257,403	4,109,226	19,471,584	15,689,554	747,689,580

United Kingdom			1,347,600	105,619,710	68,120	157,583	33,552	4,285,424	4,587,562	116,099,551
Belgium				7,887,182				224,160	189,886	8,301,228
Denmark				8,520,252			44,774	64,354	963,063	9,592,443
France	250,880			89,188,652			386,564	456,355	1,505,510	91,787,961
Germany				6,831,400						6,831,400
Italy				65,343,538				1,174,289	9,155,242	75,673,069
Netherlands			49,660	14,981,725	1,156		844,945	618,100	5,911,342	22,406,928
Norway			223,948	3,568,709			419,691	270,791	15,512,542	19,995,681
Switzerland				11,854,687	3,919		1,500	133,896	3,548,607	15,542,609
Other Europe				35,617,023			433,969	642,323	5,679,445	42,372,760
Canada	256,966	160,821	45,368	19,781,227	39,318	125,692	537,196	1,798,426	1,157,713	23,902,727
Japan				65,595,603	200	738	1,524	138	46,444	65,644,647
Other countries			7,835	3,371,110	251,376	165,791	3,290,244	4,096,169	7,294,246	18,476,771
	507,846	160,821	1,674,411	438,160,818	364,089	449,804	5,993,959	13,764,425	55,551,602	516,627,775

[a] Figures cover six months, July to December.

Brass exported from the United States in 1917–1919.

	1917		1918		1919	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Brass:	*Pounds.*		*Pounds.*		*Pounds.*	
Scrap and old	8,298,989	$1,758,384	4,909,820	$799,318	1,321,767	$176,028
Bars, plates, and sheets	328,346,666	101,521,426	30,989,717	9,522,934	7,770,671	2,310,561
Cartridge shells, empty	.....	[a] 3,533,834	.....	566,829	.....	169,961
Pipes and fittings	[a] 916,895	[a] 402,167	.....	1,137,336	.....	1,413,875
Wire	[a] 1,804,741	[a] 729,768	1,748,883	707,287	1,115,908	403,899
All other manufactures of	.....	131,945,530	.....	17,071,694	.....	9,438,554
	339,367,291	239,891,109	37,648,420	29,805,398	10,208,346	13,912,878

[a] For six months beginning July 1, 1917.

Unmanufactured brass exported from the United States, 1913–1919.

Year.	Brass in bars, plates, sheets, etc.		Year.	Brass in bars, plates, sheets, etc.	
	Quantity (pounds).	Value.		Quantity (pounds).	Value.
1913	6,111,463	$933,949	1917	328,346,666	$101,521,426
1914	7,115,807	909,153	1918	30,989,717	9,522,934
1915	66,272,144	12,435,782	1919	7,770,671	2,310,561
1916	244,531,706	72,683,626			

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1919 was 914,000,000 pounds. In 1918 it was 1,662,000,000 pounds. The method employed in determining the quantity of copper retained for consumption is shown in the following table, which does not include stocks of copper held by consumers:

Apparent domestic consumption of refined new copper, 1914–1919, in pounds.

	1914	1915	1916	1917	1918	1919
Total supply of new copper	1,533,781,394	1,634,204,448	2,259,387,315	2,428,546,171	2,432,385,290	1,805,306,801
Stock at beginning of year	90,385,402	173,640,501	82,429,666	128,055,229	114,000,000	180,000,000
Total available supply	1,624,166,796	1,807,844,949	2,341,816,981	2,556,601,400	2,546,385,290	1,985,306,801
Copper exported [a]	748,902,137	588,797,096	734,879,881	1,047,771,685	704,715,714	439,835,229
Stock at end of year	173,640,501	82,429,666	128,055,229	114,000,000	180,000,000	631,000,000
Total withdrawn from supply	922,542,638	671,226,762	862,935,110	1,161,771,685	884,715,714	1,070,835,229
Apparent consumption	701,624,158	1,136,618,187	1,478,881,871	1,394,829,715	1,661,669,576	914,471,572

[a] Includes unrefined black blister and converter copper, in bars, pigs, or other forms, and refined copper in ingots, bars, rods, or other forms.

If to the 914,470,000 pounds of new refined copper is added the 574,380,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of about 1,489,000,000 pounds of new and old copper was available for domestic consumption.

Domestic consumption of new copper, 1906–1919.

	Pounds.		Pounds.		Pounds.
1906	677,434,937	1911	681,753,279	1916	1,478,881,871
1907	487,771,625	1912	775,978,332	1917	1,394,829,715
1908	479,955,318	1913	812,268,639	1918	1,661,669,576
1909	688,565,243	1914	701,624,158	1919	914,471,572
1910	732,405,180	1915	1,136,618,187		

The figures of apparent domestic consumption do not closely represent the copper that was manufactured in the United States during the World War. The figures for domestic consumption for 1915–16 indicate a great increase, which was due, however, to the manufacture of munitions and other material exported to the Allied countries and not absorbed by domestic use.

The figures showing the vast quantities that were apparently consumed in 1917–18 by the United States are also misleading, as a very large percentage, probably half in 1918, was used in the manufacture of munitions for both the American and the Allied armies.

The figures for 1919, which show a tremendous decrease in domestic consumption, are also probably somewhat misleading, as it is unlikely that the 914,000,000 pounds which appears as domestic consumption was actually utilized in the manufacture of material for domestic use. It is probable that the actual quantity of copper which was manufactured and absorbed by domestic industry in 1919 was appreciably lower than the figure given for apparent domestic consumption. The apparent domestic consumption represents both a large quantity of copper that was acquired by the domestic consumers at such favorable prices that it could be held as stock and utilized when the necessity demanded it and also the quantity that was actually consumed.

USES.

There are no data available showing the quantity of copper that entered the different industries, and the great changes due to the war render any estimate more uncertain than usual.

The following table shows the copper cast in different forms in 1919. It will be noted that the total is not the same as the production of refined copper:

Copper cast in different forms in 1919.

Form.	Quantity (pounds).	Percentage.
Wire bars	1,014,475,451	55
Ingots	455,885,298	25
Cakes	138,520,990	8
Cathodes	131,594,079	7
Other forms	98,982,363	5
	1,839,458,181	100

PRICES.

The average price received for copper delivered by the producers in 1919 and the price used by the United States Geological Survey in calculating the value of the copper output was 18.6 cents a pound. The average received by selling agencies for 1,393,900,000 pounds, as reported to the Geological Survey by selling agencies, was 18.57 cents a pound.

The following table shows the average quoted price of copper at New York, as reported by the American Metal Market Co. and by the Engineering and Mining Journal for 1913 to 1919, inclusive:

Average monthly prices at New York per pound of electrolytic copper in 1913–1919, in cents, as reported by the American Metal Market Co.

Month.	1913	1914	1915	1916	1917	1918	1919
January	16.755	14.45	13.71	24.10	30.26	23.50	20.05
February	15.27	14.67	14.57	27.46	35.22	23.50	16.91
March	14.925	14.335	14.96	27.44	35.74	23.50	15.01
April	15.48	14.34	17.09	29.31	32.19	23.50	15.40
May	15.63	14.13	18.60	29.81	32.32	23.50	16.005
June	14.85	13.81	19.71	27.49	32.57	23.50	17.655
July	14.57	13.49	19.08	25.60	28.90	25.89	21.71
August	15.68	12.415	17.22	27.36	27.13	26.00	22.22
September	16.55	12.085	17.70	28.26	25.45	26.00	21.95
October	16.54	11.40	17.86	28.64	23.50	26.00	21.505
November	15.47	11.74	18.83	32.22	23.50	26.00	19.96
December	14.47	12.93	20.35	33.84	23.50	25.285	18.48
Average	15.52	13.315	17.47	28.46	29.19	24.68	18.905

Average monthly prices at New York per pound of electrolytic copper in 1913–1919 as reported by the Engineering and Mining Journal.

Month.	1913	1914	1915	1916	1917	1918	1919
January	16.488	14.223	13.641	24.008	28.673	23.50	(a)
February	14.971	14.491	14.394	26.440	31.750	23.50	16.763
March	14.713	14.131	14.787	26.310	31.481	23.50	14.856
April	15.291	14.211	16.811	27.895	27.935	23.50	15.246
May	15.436	13.996	18.506	28.625	28.788	23.50	15.864
June	14.672	13.603	19.477	26.601	29.962	23.50	17.610
July	14.190	13.223	18.796	23.865	26.620	25.904	21.604
August	15.400	(b)	16.941	26.120	25.380	26.00	22.319
September	16.328	(b)	17.502	26.855	25.073	26.00	21.755
October	16.337	(b)	17.686	27.193	23.500	26.00	21.534
November	15.182	11.739	18.627	30.625	23.500	26.00	19.758
December	14.224	12.801	20.133	31.890	23.500	(a)	18.295
Average	15.269	13.602	17.275	27.202	27.180	24.628	18.691

[a] No market. [b] Price not quoted.

COPPER IN FOREIGN COUNTRIES.

SOURCES OF INFORMATION.

In the following discussion of the copper production by the principal copper-producing countries of the world the most reliable sources of information available have been drawn on.

For Canada the official publication by the Canada Department of Mines, the annual report of the mineral production of Canada, the annual reports by the Department of Mines of the various Provvinces, the technical press, the Commerce Reports of the United States Government, and the annual reports of the operating companies have been consulted and have furnished the information.

For Mexico the Boletín minero, the official statistical publication of the Mexican Government, the Commerce Reports of the United States Government, the technical press, and the annual reports of the operating companies have supplied the information.

For Chile the official statistics for the year are not available, and the statistics and other information are based on the Commerce Reports, the technical press, and the annual reports of the operating companies.

The statistics of production and much information covering the general conditions of the copper industry and the salient features for the year in Peru were obtained from the Boletín del Cuerpo de ingenieros de minas and Estadística minera, the official publication of the Peruvian Government. This information was supplemented by information obtained from the technical press, Commerce Reports, and the annual reports of the companies operating in Peru.

The statistics and general information contained in the discussion of Spain were obtained from Estadística minera de España, Consejo de minería, the official statistical publication of Spain. This information was also supplemented by information obtained from the technical press and the Commerce Reports.

No official statistics were available for Belgian Kongo, and the discussion is based entirely upon information published by the companies operating in that region.

The annual report of the Department of Mines of New South Wales, the Under Secretary for Mines of Queensland, the Secretary for Mines of Victoria, the Secretary for Mines of Tasmania, and the Department of Mines of Western Australia, and the Mining Review of the Department of Mines of South Australia have furnished much of the information covered in the discussion on Australia. The technical press, Commerce Reports, and the annual reports of the operating companies have supplied the remaining material.

The figures and information pertaining to the mining, milling, and smelting operations of individual companies are taken from the companies' annual reports.

CANADA.

Canada's importance as a producer of copper dates from about 1886, and since that time her production has been constantly increasing. This increase was due in former years almost entirely to the development of copper mining in British Columbia and of nickel and copper mining in Ontario. In recent years Manitoba has become a promising factor; and Yukon also has contributed appreciably to the Canadian output, particularly during the World War. For many years the Province of Quebec has made some production, principally from pyritic ores, which are mined primarily for their sulphur content. In British Columbia several of the larger districts are apparently nearing exhaustion, but new districts, which appear to be as promising as the older ones, are being developed. In Ontario, where the copper is derived almost entirely from nickel-copper ore, the reserves of ore are still very great.

Smelting and refining have developed much more slowly in Canada than mining, and refined copper was produced there for the first time in 1916. A very large part of the Canadian output is still shipped as matte, concentrates, and ore to the United States for smelting and refining, and it is estimated that 20,804,471 pounds of copper was produced from such material in 1919. The total pro-

duction of refined copper in Canada in 1919 was about 3,467 tons (6,934,000 pounds), which was nearly all produced at the electrolytic refinery of the Consolidated Mining & Smelting Co., at Trail, B. C., although a few tons was produced at the International Nickel Co.'s refinery at Port Colborne, Ontario. The larger part of the production of the International Nickel Co.'s plant, however, is blister.

In 1919 British Columbia was the largest producer of copper in Canada, followed in order by Ontario, Manitoba, Quebec, and Yukon. The production from these five Provinces represents practically the total Canadian production.

Canada experienced the same troubles in 1919 in the copper-mining industry that were experienced in the United States. The unfortunate market conditions, the large stocks in hand, the curtailed production, and the unsatisfactory labor conditions worked a great hardship on the copper-mining companies and made the year unsuccessful.

British Columbia.—The production of copper in British Columbia decreased from 62,865,681 pounds in 1918 to 44,502,079 pounds in 1919. The principal producers were the Howe Sound Co., Granby Consolidated Mining & Power Co., Canada Copper Corporation, Consolidated Copper Smelting & Refining Co., Marble Bay Co., and the Surf-Inlet Mines Co. (Ltd.).

The Howe Sound Co. made the largest production and mined and milled a greater quantity of ore than in 1918. The company's operations were so greatly handicapped by the scarcity of labor and the high cost of supplies that no new development work was undertaken, although the development of known ore bodies was continued. This company produced, from 615,300 short tons of ore, 17,330,844 pounds of copper, 4,350 ounces of gold, and 99,863 ounces of silver.

The company estimates that its reserves amount to 5,299,000 tons of ore, averaging about 2 per cent of copper. In the same district or coast section the Surf-Inlet mines, a subsidiary of the Tonopah Belmont Co., operated throughout the year and accomplished a considerable amount of development work. About 103,927 dry tons of ore was mined and treated, from which 9,515 tons of concentrates were produced that yielded 810,388 pounds of copper, 51,684 ounces of gold, and 30,319 ounces of silver. The concentrates were shipped to Tacoma, Wash., for treatment.

The Granby Consolidated Mining, Smelting & Power Co. operated its smelter at Anyox and its mines at Hidden Creek for about 10 months of the year. About 647,466 tons of ore was mined from the Hidden Creek deposits and smelted at Anyox. The ore yielded 19,544,588 pounds of copper, 348,408 ounces of silver, and 4,688 ounces of gold. The output of copper represents a decrease from 1918 of about 9,700,000 pounds.

In the Trail Creek mining division the Consolidated Copper Mining & Smelting Co. operated its mines very satisfactorily throughout the year, with a production of about the same as for 1918. The Consolidated Copper Mining & Smelting Co. produced about 1,500,000 pounds of copper, and it is reported that the company intends to erect a large concentrating plant for the treatment of the low-grade ores.

In the southern district the Canada Copper Corporation has developed approximately 12,000,000 tons of low-grade ore in its Copper Mountain property, but has not yet begun extensive mining operations, there still being some construction and railway work to be completed. The Canada Copper Corporation throughout the year devoted itself to the development of its ore bodies and to the completion of its surface equipment. The railway strike greatly hampered the company in its operations in 1919.

The Granby Consolidated Mining, Smelting & Power Co. operated its mines throughout the year but produced only 143,000 tons of ore, a decrease from the production in 1918 of about 300,000 tons.

Many other companies made small outputs in 1919 or devoted themselves to development work. Some of the mines which were previously important producers, as the Rocher-Déboulé, were closed for the year.

Altogether the year was a very unfortunate one for the copper-mining industry of British Columbia, and there can be no material improvement until the international conditions of the industry have been materially remedied.

Ontario.—The production of copper in Ontario in 1919 was 24,346,623 pounds from the copper ore from the Sudbury district, from the Alexo mine in Timiskaming, and from the copper ores of the Bruce mine in the Sudbury district, supplemented by a smaller recovery of copper from the silver ore of the Cobalt district.

Manitoba.—The output of copper in Manitoba in 1919 amounted to 3,348,000 pounds and was derived from the rich chalcopyrite lens discovered in the Mandy ore deposits. This district appears to have a very promising future in production of copper from low-grade ore. It is reported that the Flin Flon deposits contain 20,000,000 tons of primary sulphides, averaging about 1.7 per cent of copper and 1.5 ounces of silver and $1.40 in gold to the ton. Considerable development work has been undertaken in these deposits, particularly the Flin Flon, and with the completion of a railway they should become large producers.

Quebec.—The production of copper in Quebec was about 2,691,695 pounds in 1919, which represents a decrease from the production of 1918 of about 3,177,954 pounds. The copper was derived entirely from ores mined primarily for their sulphur content, and the copper was recovered as a by-product.

Yukon.—The production of copper in Yukon decreased from 619,878 pounds in 1918 to 165,184 pounds in 1919, all of which was derived from the copper ores of the White Horse district.

MEXICO.

Copper has been produced in Mexico for many years, but the importance of Mexico as a copper producer is recent and began with the development of the Greene Cananea, Moctezuma, and Boleo deposits. Copper mineralization is very extensive in Mexico and there are few if any States in which it is not found. By far the largest deposits are in Sonora, Sinaloa, and Baja California. The entrance of American and European capital into Mexico within the last 30 years gave the copper-mining industry a tremendous impetus, which resulted in constantly increasing production until the revolu-

tions began in 1910. Since that time there has been very little development of new properties, and the production has been derived very largely from three principal mines.

The recent reorganization of the Mexican Government, together with the encouragement that the Government is offering for the development of its natural resources, promises a new era in the history of Mexican mining. Of course the conditions that affected the Canadian and American copper industries also affected the Mexican industry, and the production was consequently considerably curtailed.

The principal producing companies were, in 1919, as heretofore, the the Greene Cananea Copper Co., the Moctezuma (subsidiary to the Phelps Dodge Corporation), and the Compagnie du Boleo.

The Greene Cananea Co. as usual made the largest production—41,404,810 pounds of copper, 1,739,790 ounces of silver, and 9,168 ounces of gold—which was derived from 230,713 tons of concentrating ore, and 696,151 tons of direct smelting ore. The cost of production, including all expenses and Federal taxes, was 14.75 cents a pound of copper, which compares favorably with 15.082 cents a pound for 1918. The average cost of mining copper was $3.6428 a ton, which compares unfavorably with $3.24 a ton in 1918.

The mines and works of the company were operated throughout the year at a reduced rate, which the company reports was caused by the unsatisfactory market conditions. Advantage was taken of the curtailed operations to continue extensive repairs and construction work and to initiate new and carry on old development work that had not been possible for several years. The ore reserves at the end of 1919 were approximately the same as at the end of 1918, the new ore developed being equivalent to the ore extracted during the year. The ore yielded, per dry ton, 47.66 pounds of copper, 1.967 ounces of silver, and 0.010 ounce of gold. The concentrates amounted in 1919 to 220,821 dry tons, in the ratio of 3.365 to 1, at a cost of $1.876 a ton; and 715,621 dry tons of new copper ore was smelted at a cost of $3.51 a ton.

Copper produced by the Greene Cananea Copper Co., Mexico, 1918–19.

Year.	Ore mined.	Ore smelted.	Copper content.	Silver.	Gold.	Cost per pound.
	Wet tons.	*Dry tons.*	*Pounds.*	*Ounces.*	*Ounces.*	*Cents.*
1918	1,162,826	902,520	53,349,643	1,698,010	14,741	15.082
1919	926,864	715,621	41,404,810	1,739,790	9,168	14.750

The Moctezuma Copper Co., a subsidiary to the Phelps Dodge Corporation, produced 27,943,000 pounds of copper, 432,001 ounces of silver, and 2,211 ounces of gold. The net production based on smelter returns was 26,545,857 pounds of copper, 407,538 ounces of silver, and 2,162 ounces of gold. The company curtailed its operations at the beginning of the year.

The ore produced from the Pilares mines amounted to 466,289 tons, averaging 3.438 per cent of copper. The concentrator treated about 445,871 tons of copper ore of the grade mentioned in the ratio of 4.2 to 1. The considerable exploration and development work

carried on during the year was considered satisfactory. The company plans to remodel and increase the capacity of its mill to 3,000 tons a day.

Copper, silver, and gold produced by the Moctezuma Copper Co., 1918–19.

Year.	Ore.	Copper content.	Silver.	Gold.
	Short tons.	*Pounds.*	*Ounces.*	*Ounces.*
1918	200,932	45,131,950	990,575	11,580
1919	108,728	27,943,012	432,001	2,211

The Compagnie du Boleo operated its mines throughout the year at a considerably reduced rate. The company had trouble during the year with labor in its mines, owing to the political agitation that resulted in the formation of the new Mexican Government. The company mined during the year 194,800 metric tons (214,700 short tons) of ore, against 263,700 metric tons (290,700 short tons) in 1918. The smelter treated 195,500 metric tons (215,500 short tons) of ore, averaging 4.11 per cent and yielding 8,000 tons (17,637,000 pounds) of copper, which was about 1,400 tons (3,086,000 pounds) less than the production in 1918. The company announces that the Compagnie des mines de Huaron, in which it is interested, has begun to produce and that the situation of the Compagnie d'Inguaran, in which it is also interested, is without change.

The Democrata mine, in Sonora, which has been one of the large producers of Mexico, shut down in March and resumed operations in November, 1919. The exact production of this mine is not known, but it is estimated at about 5,000,000 pounds.

The remaining one of the larger copper producers of Mexico is the Mazapil Copper Co. (Ltd.), in the State of Zacatecas. This company's production for 1919 is not known, but it is estimated to be about 7,500,000 pounds of copper.

The remainder of the production of Mexico is derived from a great many small mines. Practically all the Mexican copper is exported to the United States as blister, matte, ore, and concentrates for smelting and refining.

CHILE.

For many years Chile was the largest producer of copper in the world, but about 1870 the production in the United States exceeded that of Chile, and from that time until a few years ago the Chilean production was of little and variable importance. At the beginning of the present century American, French, and British capital took an active interest in the Chilean copper deposits, and since that time the Chilean production has been rapidly increasing in value, and Chile in 1918 ranked second only to the United States as a producer of copper. Copper mineralization is very extensive in Chile, but so far only a few of the larger deposits are being mined. The principal operators in Chile are the Andes Copper Co., a subsidiary to the Anaconda Copper Mining Co.; Braden Copper Co.; Chile Copper Co.; Société des mines de cuivre de Catemore; Central Chile Copper Co. (Ltd.); Société des mines et usines de cuivre de Chemaral; Société des mines de cuivre de Naltagua; Santiago Mining Co., and Poderosa Mining Co. (Ltd.).

The largest copper producer in Chile is the Chile Copper Co., which produced 38,359 short tons of copper in 1919. The production was curtailed because of the condition of the market, but the company had very little of the labor trouble from which most other companies suffered throughout the year. Practically no development work was done, and operations were confined to a curtailed output. The cost of production, in spite of the curtailed output, was lower than in 1918, being 13.01 cents a pound, as compared with 13.30 cents in 1918.

Ore reserves of the Chile Copper Co. on Dec. 31, 1919.

[Positive and probable ore.]

	Quantity.	Copper content.
	Short tons.	*Per cent.*
Oxidized ore	333,550,866	1.91
Mixed ore	151,000,000	2.98
Sulphide ore	210,000,000	1.84

Copper produced by the Chile Copper Co., 1916–1919.

Year.	Ore crushed.	Copper in ore crushed.	Average of ore crushed per operating day.	Copper produced.	Net recovery.
	Short tons.	*Per cent.*	*Short tons.*	*Pounds.*	*Per cent.*
1916	1,739,812	1.72	4,887	41,305,477	77.7
1917	2,904,191	1.757	8,067	88,370,188	81.81
1918	3,745,083	1.64	10,762	102,136,658	82.2
1919	2,961,465	1.62	11,303	76,717,872	86.0

The Braden Copper Co. produced 21,001 short tons of blister copper in 1919. The operations of the company were very greatly curtailed, particularly during the first seven months of the year. The company experienced considerable difficulty with labor during the year, but these troubles were finally settled successfully, not, however, without considerable loss to the company in production and to the men in wages. The costs of the company were rather high during the year and would have been higher because of the curtailed output and the high cost of supplies and labor but for the very favorable rate of exchange. Practically no development work was done in 1919 except in development of power.

Copper produced by the Braden Copper Co., 1917–1919.

Year.	Ore.		Copper content of ore treated.	Concentrates produced.	Blister copper produced.	Net copper saving.
	Quantity treated.	Daily average.				
	Short tons.	*Short tons.*	*Per cent.*	*Short tons.*	*Pounds.*	*Per cent.*
1917	1,799,694	4,931	2.319	158,807	63,774,000	76.61
1918	1,962,956	5,378	2.477	192,215	77,152,000	78.75
1919	1,176,794	3,224	2.161	105,212	42,002,000	80.08

Ore reserves of the Braden Copper Co., Dec. 31, 1919.

	Quantity.	Copper content.
	Short tons.	*Per cent.*
Positive ore	174,600,585	2.45
Probable ore	92,000,000	1.91

The Andes Copper Mining Co. devoted itself entirely to development work in 1919 and has already proved by churn drilling 120,000,000 tons of ore, containing 1.48 per cent of copper. The company reports that there still remains a large and promising area to be drilled. The company has not yet undertaken production but is rapidly preparing itself to make a very large output when the copper situation justifies it.

The Santiago Mining Co., another subsidiary to the Anaconda Copper Co., devoted itself entirely to satisfactory development work in its Aguirre and African mines. The company is not producing yet, but it probably will make large production when the copper market shows a sufficient improvement.

The Société des mines de cuivre de Naltagua mined during the year 49,141 metric tons of ore, which yielded 2,721 tons of blister copper of 99.1 per cent of copper. The product of the company was sold for the first half of the year in the United States and for the second half in France.

The Central Chile Copper Co. (Ltd.), which has been a considerable producer of copper, operated only a part of the year, the smelter being closed down for five months. The production of the company for the year is estimated to be about 1,000 tons of copper.

The Société des mines de cuivre de Catemore also reduced its operations largely in 1919; its production is estimated at about 6,000,000 pounds.

The Société des mines et usines de cuivre de Chemaral suspended operations early in 1919 but resumed them later in the year. The production of this company is estimated to be about 3,000 tons of copper for the year.

The Poderosa Co. operated during the year and produced about 460 tons of copper.

PERU.

Peru is one of the old copper producers of the world, its production probably antedating the Spanish conquest. It was not, however, until the advent of American and English capital that the Peruvian production of copper assumed its present proportions. Since then the output has increased very rapidly; most of it was derived from the Cerro de Pasco, Morococha, and Casapalca districts. The production in 1913 was 27,776 metric tons (61,235,000 pounds), and in 1919, in spite of that being an unfortunate year in Peru as well as in the other copper-producing countries, it was 39,230 metric tons (86,486,000 pounds). The copper mineralization is very extensive in the Andean region, but the production was derived almost entirely from the three districts mentioned.

The Cerro de Pasco Copper Corporation is by far the largest producer in the country. The conditions of the copper market in 1919

forced curtailed operations in Peru, but owing to the high silver content of the ores from the Cerro de Pasco, Morococha, and Casapalca mines, and the high price of silver throughout the year, the reduction in operations was less extensive than in any other copper-producing region of the world. The Cerro de Pasco Copper Corporation smelted at Cerro de Pasco, 58,124,230 pounds of copper in 1919, against 71,904,794 pounds in 1918. The production by the Casapalca smelter of the Sociedad minera Bacus & Johnston, which is owned by the Cerro de Pasco Copper Corporation, was 22,281,360 pounds of copper in 1919, against 24,619,561 pounds in 1918. The Cerro de Pasco blister is reported to have an average silver content of 140 ounces to the ton and the ore treated at the Casapalca smelter has an even greater silver content. The high silver content of the ores treated at the Casapalca smelter is probably one of the reasons for the very slight decrease in the output of that smelter during the year. This corporation, both owing to the high silver content of its ores and also to the relatively low cost of mining and smelting, has been able to meet the present unfortunate condition of the copper industry in a much more satisfactory manner than most of the producers.

The salient incidents of the Peruvian copper-mining industry in 1919 were the reported purchase of the Cerro Verde mine by the Andes Exploration Co., the definite incorporation of the Bacus & Johnston Co. in the Cerro de Pasco Corporation, and the beginning of the construction by the Cerro de Pasco Corporation of its new smelter at La Aroya, with a reported capacity of 3,000 tons a day. This smelter, when completed, will replace the smelter at Quiruvilca. Among the other recent incidents of interest is the reported formation of an American mining syndicate which purposes, with the preliminary investment of $15,000,000, to operate the Hualgayoc copper mines and to construct a smelter and also a railway to connect the mines with the coast. The Cerro Verde mine is in the Department of Arequipa. The district in which the mine is situated has been worked for a long time for silver ore but has so far never been a noted producer of copper. The ore is reported to occur as a disseminated deposit in rhyolite near the contact of a porphyritic diorite. The deposit is reported to contain more than 10,000,000 tons of ore, averaging from 2 to 2.5 per cent of copper.

The Hualgayoc district is in the Department of Cajamarca, at an altitude of about 12,000 feet. The ore is reported to occur principally as veins in limestone, shale, and sandstone and is associated with the igneous rocks that have intruded the sedimentary rock. The copper minerals are principally sulphides, carrying considerable silver and some gold, and the district is considered promising.

SPAIN.

Spain is one of the earliest copper producers and was a very important source of copper in the days of the Phoenician empire. It has made a steady production of copper for almost 3,000 years, and at the present time is the most important producer in Europe. Under normal conditions the production is about 30,000 to 40,000 metric tons annually. The reaction from the war was even more seriously felt in Spain than in other copper-producing countries.

Production for 1919 fell to 11,307 metric tons of cement copper, 10,216 tons of blister copper, and 1,896 tons of wire, rods, and ingots, which was derived from 864,414 tons of copper ore and 605,677 tons of cupriferous pyrite, according to the figures of the Consejo de minería, as published in the Revista minera, metalúrgica y de ingeniería.

The principal part of the output of copper was cement copper, which is precipitated from solutions derived from leaching piles of copper ore. The blister was derived from higher grade smelting ores. The Rio Tinto Co. (Ltd.), the Tharsis Sulphur & Copper Co. (Ltd.), the United Alkali Co. (Ltd.), the Pena Copper Mines (Ltd.), the Huelva Copper & Sulphur Mines (Ltd.), the Esperanza Copper & Sulphur Co. (Ltd.), and the Cordova Copper Co. (Ltd.) were the principal operators in 1919. In 1919 the Cordova Co. produced about 284 tons of blister copper and the Huelva Copper Co. produced about 4,437,440 pounds of copper from 61,996 tons of company ore and 7,625 tons of custom ore. The production of the Rio Tinto Co. is not known but is probably about 35,000,000 pounds. The San Miguel Copper Mines (Ltd.), which ordinarily produce about 1,000,000 pounds of copper a year, were closed in 1919 and the production is not known. The production of the Tharsis Sulphur & Copper Co. is also unknown, but it is estimated at about 2,500 tons for 1919. The United Alkali Co. also operated during the year, but its production is not known.

The industrial situation in Spain which is reported to have been unfavorable for mining operations for some time, has evidently undergone a general transformation recently, particularly since the war. The Spanish copper mines are evidently in a position at the present time to market a greater output than before the war. The return of Spain to an important place in the copper market of the world is evidently only a matter of a short time.

JAPAN.

Japan was for some years (1912–1917) the second largest producer of copper in the world; but it is likely that in 1918 the Chilean production exceeded that of Japan. Copper mineralization is rather extensive in Japan but occurs principally in the central part. The deposits are of two definite types and are operated by the Mitsu-Bishi, Turukawa, Tujita, Kuhara, and Dubenkibo companies. These companies are in the nature of closed corporations and do not publish yearly reports of operations, or at least the reports are generally unavailable, if published; consequently a description of the operations of the principal companies for the year is impossible.

Japan, under ordinary circumstances, produces considerably more copper than she consumes, the excess being exported principally to China, India, and England.

Japan also imports a considerable quantity of manufactured copper, which is reexported largely as brasses and bronzes.

The Japanese copper industry underwent the war reaction and the difficulties common to the copper industry of the world, but the Japanese producers were fortunate in having contracts with Chinese, Indian, and other consumers which permitted more favorable operations through 1919 than was general in the industry. However, the great imports which Japan maintained through 1918 and a large part

of 1919 and the continued production, brought about the reaction in the industry in 1920. It is reported that early in 1920 the copper market of Japan was in the worst condition that it had ever experienced; however, the banks furnished considerable financial relief, which greatly modified the situation. The inability to dispose of considerable stocks at an advantageous price and the inability of weak holders to sell their accumulated stocks brought the price of copper down so low that much of it was sold at less than the cost of mining. As a result the production of smelted and refined copper has been considerably curtailed. By the middle of 1920 about 16 of the leading copper mines, each of which is supposed to produce more than 200,000 pounds a year, were temporarily closed, and many of the smaller ones are reported to have been abandoned by their operators since March, 1920. Notable among those which have been closed is the Yasaka mine, which is reported to be one of the big mines of Japan. The cost of production, particularly through labor demands for higher wages, etc., had increased so rapidly that by June, 1920, the general cost of production was considerably above the average price for electrolytic copper. A further decrease of 35 per cent in production was predicted for the remainder of 1920.

Copper produced in Japan, imported and exported, 1913–1919, in pounds.

Year.	Production.	Imports.	Exports.
1913	146,608,000	(a)	94,854,748
1914	155,343,000	(a)	102,060,764
1915	166,262,000	(a)	132,397,376
1916	221,862,000	6,917,612	139,116,252
1917	238,181,000	11,968,084	175,108,840
1918	199,168,000	1,957,828	91,670,905
1919	172,937,000	62,017,409	54,013,272

a Figures not available.

BELGIAN KONGO.

The copper deposits of the Katanga region of Belgian Kongo, though their extent is not known with any degree of certainty, are considered among the most important in the world. The known copper belt is about 200 miles long and contains more than 100 known copper deposits. The Tanganyika Concessions (Ltd.) and the affiliated organizations, particularly the Union minière du Haut Katanga, control the most valuable of these deposits and at present are marketing practically the entire product of the region. The work already done is reported to have developed more than 300,000,000 tons of ore, 40,000,000 tons of which carries 8 per cent of copper and lies above the water level in the Katanga mines. The production of this company for the year 1919 is estimated by the company to be about 22,000 tons. The output would have been about 40,000 tons, but operations were very largely curtailed on account of strikes and the general disorganization of the railways and colliery.

The smelter capacity of this company has reached 40,000 tons a year, and with the return of the copper industry to a normal basis the smelter will be operated at full capacity. In addition to the plant for treating the high-grade ores, a concentrating plant capable of treating 4,000 tons of ore a day is in course of erection. It is reported by the company that this plant should be in operation by

the end of 1920. A test plant designed to treat a large part of the company's ore by the electrolytic leaching process has proved a success, and the new 4,000-ton plant is designed to put the test operations upon a commercial basis. The company expects, in addition to this plant, ultimately to erect a larger plant of the same nature on the headwaters of Lualaba River. The company has also decided to carry on ore development on a large scale in the western section of the copper belt, with the object of supplying the proposed extensive electrolytic leaching works on Lualaba River. With the completion of these two new plants the production of the company will be very greatly increased. The company expects in a very short time to have the first 4,000-ton concentrating plant completed and in operation.

AUSTRALIA.

Australia has been an important producer of copper for more than 20 years, and during the war maintained a large and steady production, which assisted materially in supplying the Allied countries with the copper they needed. The maximum production of 46,343 metric tons was made in 1912. Queensland, New South Wales, Tasmania, South Australia, and Western Australia are the chief producers. The condition of the copper industry after the war was unfortunate in Australia. As the Australian market was affected by the withdrawal of contracts by the British Government, by the restrictions imposed on copper during the war, and by the fact that there was about 36,000 tons of copper in reserve, it presented almost no demand, and consequently the production of copper was very greatly curtailed throughout the country. Shipping difficulties, labor troubles, and increase in cost of supplies and labor were the additional causes for an unfortunate year in the industry. The production of refined copper in Australia for 1919 was 11,653 tons, and the normal local consumption is about 5,000 tons. Copper imports into Australia are confined entirely to the manufactured products. The total production of copper for Australia for the year was about 42,564,000 pounds.

Queensland.—Queensland is the leading producer of copper in the Commonwealth, and in 1919 produced 9,996 long tons (10,156 metric tons) of copper, which was about half of the production in 1918. The principal producers for the year were the Mount Morgan Gold Mining Co. (Ltd.), Hampden Cloncurry Mines, Mount Elliott Co. (Ltd.), and Mount Cuthbert Co.

The Mount Morgan Co. produced 5,384 tons of copper in 1919. The production for the company's year, which ends May 30, 1920, was 6,268 tons of copper and 80,578 ounces of gold, produced from 178,055 tons of ore, treated to make 67,836 tons of concentrates. At the end of the year, May 30, 1920, the company had developed 3,437,687 tons of ore, which averaged 2.59 per cent of copper and 6.11 pennyweight of gold.

The Hampden Cloncurry Mines produced 1,151 tons of copper in 1919. The Hampden Cloncurry smelter closed down during the greater part of the year, and the company devoted itself very largely to development work. The ore reserves for the year were estimated by the company to be about 218,000 tons, which included 123,000 tons of direct smelting ore.

The Mount Elliott Co. (Ltd.) also very largely reduced its operations. The production of copper in 1919 was 903 tons. Considerable development work was undertaken, and the reserves, estimated by the company to be 1,876,000 tons, represent a slight increase over the developed reserves for 1918. The smelter of the Mount Elliott Co. was closed January 26 and remained closed for the rest of the year.

The Mount Cuthbert Co. did not begin its smelting operations until October 11, 1919, and as a result its production was far below normal. The company is making some smelting experiments which have resulted satisfactorily, and the lowering of the cost of producing copper is expected.

The Cloncurry district, in which all these mines except the Mount Morgan are situated, produced only 4,346 tons of copper for the year, which compares unfavorably with the production of 11,625 tons for 1918.

South Australia.—South Australia produced 5,638,000 pounds of copper in 1919. The principal producer in this State is the Wallaroo & Moonta Mining & Smelting Co. Operations by this company were suspended for some time during 1919, and the production fell much below normal. The Wallaroo & Moonta Co. produced only about 906 tons of copper in 1919.

Tasmania.—The production of Tasmania for 1919 was about 5,027 long tons (5,108 metric tons). The principal operators in Tasmania are the Mount Lyell Mining & Railway Co. and the Mount Reed & Roseburry Mines (Ltd.).

The Mount Lyell Co. produced during the year about 3,554 tons of blister copper. The production of this company for the year ending September 30, 1919, was 5,314 tons of copper, 266,864 ounces of silver, 5,538 ounces of gold, from 176,569 tons of smelting ore and 7,890 tons of concentrates. The ore reserves of this company at the end of its fiscal year were reported to be 1,910,388 tons in the Mount Lyell mine and 960,242 tons in the North Mount Lyell. Satisfactory development work was carried on by the company during the year, and the flotation plant for the concentration of the low-grade ores operated satisfactorily throughout the year.

New South Wales.—The production of copper in New South Wales for the year was considerably lower than in 1918, being only about 3,268,000 pounds of copper. The principal operator in the State was the Great Cobar Mines, which produced about 1,147 tons of copper. The operations by the company were considerably lower than normal and were reported to have been suspended on account of the unfavorable conditions for a considerable part of the year.

Other operators in the district are the C. S. A. Mines, the Royal Mines, and the Mount Hope Mines. The production of copper for these companies for the year is not known, but is reported as being far below normal.

The Mount Hope Mines (Ltd.) suspended mining operations in October, 1918, and leaching operations in January, 1919, and the production for the fiscal year, which ended June 30, 1919, amounted to 136.57 tons of copper, which was extracted from ore previously mined.

GOLD, SILVER, COPPER, AND LEAD IN SOUTH DAKOTA.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the gold, silver, and lead produced at mines in South Dakota in 1919 showed a decrease of 26 per cent as compared with the value of metals produced in 1918. The output of gold represented more than 97 per cent of the total value. The smelting ore and concentrates shipped from South Dakota in 1919 carried 32,547 pounds of lead. The output of placer gold was 19.16 fine ounces. There were 12 producing mines, of which 9 were deep and 3 were placers, a decrease of 7 deep mines and 3 placers, as compared with 1918.

The ore mined and treated in 1919 averaged in recovered gold 0.1768 ounce, or $3.65, per ton as compared with $3.68 in 1918. The mills of the State treated 1,329,481 tons of ore, which yielded as bullion $4,813,101 in gold and 114,257 fine ounces of silver, valued at $127,968, an average recovery per ton of $3.62 in gold and 0.086 ounce in silver, as compared with $3.68 in gold and 0.086 ounce in silver in 1918.

Gold and silver bullion produced at mills in South Dakota in 1919.

Process.	Ore treated.	Gold in bullion.	Silver in bullion.	Quicksilver used.	Sodium cyanide used.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Amalgamation	1,192,588	146,815.80	41,595	9,000	.....
Cyanidation	[a] 1,294,838	86,017.98	72,662	.....	284,653
	.....	232,833.78	114,257	9,000	284,653

[a] Includes 1,157,945 tons of sand and slimes from the ore amalgamated.

Mine production of gold, silver, copper, and lead in South Dakota in 1918 and 1919.

Year.	Number of mines producing.	Ore.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
1918	22	1,782,563	317,598.18	$6,565,337	159,202	$159,202
1919	12	1,330,368	235,249.57	4,863,040	116,493	130,472
Decrease, 1919	10	452,195	82,348.61	1,702,297	42,709	28,730

[a] Includes placer production.

Mine production of gold, silver, copper, and lead in South Dakota in 1918 and 1919—Con.

Year.	Copper.		Lead.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		
1918	64,806	$16,007	53,408	$3,792	$6,744,338
1919			32,547	1,725	4,995,237
Decrease, 1919	64,806	16,007	20,861	2,067	1,749,101

Mine production of gold, silver, and lead in South Dakota in 1919, by classes of ore.

Source.	Number of mines.	Ore.	Gold.	Silver.	Lead.
		Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*
Deep mines:					
Dry siliceous ore	7	1,330,349	235,229.25	115,733	28,755
Lead oxide ore	2	19	1.16	759	3,792
	9	1,330,368	235,230.41	116,492	32,547
Placer mines	3		19.16	1	
	12	1,330,368	235,249.57	116,493	32,547

MINING INDUSTRY.

The shortage of labor in 1918 at the Homestake mine continued in 1919, with resultant curtailed development and mining operations. Because of a fire which started September 25, 1919, on the 800-foot level, the Homestake mines and mills at Lead and Deadwood were closed from October 6 to December 9, when 260 stamps were set in motion out of the total of 1,020 stamps normally in use. The Trojan mine and 400-ton cyanidation mill at Trojan were operated continuously. The Mogul 150-ton cyanidation mill at Terry was operated continuously as a custom plant on the Ofer Co.'s ores up to September 30, 1919, when all operations ceased. The Deadwood Zinc & Lead Co.'s new 40-ton concentration mill at Deadwood was operated for 10 days. One car of silver-lead oxidized ore was shipped from the New Silver Queen mine, at Galena.

In Custer County the Spokane concentration mill, near Keystone, was operated for a short period.

REVIEW BY COUNTIES.

CUSTER COUNTY.

Early in 1919 several cars of lead concentrates were shipped from the 100-ton concentrating plant built in 1918 at the Spokane mine, between Custer and Keystone, after which all operations ceased.

LAWRENCE COUNTY.

The annual report of the Homestake Mining Co. (dated Dec. 31, 1919), of Lead, shows that during the year 1,192,588 tons of ore was milled, the proceeds of the bullion being $4,346,116. In addition $6,516 was realized from sales of wolframite ore. Details of the operations in 1919 are as follows:

Production during the first nine months of the year just ended was below normal owing to the continued shortage of labor.

On September 25 a fire started in No. 3 northwest "Drawhole" stope on the 800-foot level. Owing to the inaccessibility of the fire, it became necessary to flood the mine. The mine and mills were closed down from October 6 to December 9, during which time the water filled the mine to a height of 78 feet above the sill of the 600-foot level, covered and extinguished the fire.

On December 9 the Pocahontas mill of 160 stamps and the Monroe mill of 100 stamps were started crushing ore mined on the surface, 300, 400, and 500 foot levels, and hoisted through the Old Brig shaft, all other shafts being used to unwater the mine.

During the enforced shutdown, all employees were retained and employed on new construction, prospecting outlying mineral ground, and in making needed repairs to the surface plants.

Betterments for the year are as follows:

Two electric-driven, direct-connected air compressors, each having a capacity of 4,500 cubic feet of free air per minute, were installed and are operating satisfactorily.

The mine ventilating system was completed by the installation of a second fan unit capable of furnishing 60,000 cubic feet of air per minute, and a number of automatically operated doors for the control of air currents.

An experimental ball mill was installed at the Pocahontas mill and a number of trial runs made to test its adaptability to the reduction of Homestake ores.

An electric-driven hoist with motor generator set has been ordered and delivery promised in the early part of 1920. This hoist will be used for hoisting ore at the Ellison shaft, while the present steam-driven engine will serve as a man and material hoist.

Owing to shortage of labor and high cost of supplies, prospecting was carried on only to a limited extent. The mine engineers report as follows: In mine, development drifts driven 2,632 feet, development raises driven 1,614 feet, prospecting drifts driven 485 feet; on surface, prospecting drifts driven 1,039 feet.

The Ellison shaft was sunk an additional 119 feet, making the bottom of the shaft 45 feet below the 2,150-foot level.

There are 1,574,886 tons of ore broken down and remaining in the stopes.

The Deadwood Zinc & Lead Co.'s 40-ton concentration mill was operated for 10 days, and one car of lead concentrates was shipped.

The Trojan mill was operated every day of the year, treating a small quantity of custom ore in addition to the ore from its own property.

The Mogul cyanidation mill was operated continuously as a custom mill on ores from mines of the Ofer Co. until September 30, when all operations ceased at the Ofer mines.

Other mines from which small shipments were made were the Dark Horse-General Grant, Folger, Jessie Lee-Leopard, and Marco Polo-Angora.

From a 3,800-foot tunnel, of which 200 feet was driven in 1919, a car of lead-silver ore was shipped from the New Silver Queen mine, at Galena.

The Custer Peak Copper Co., at Roubaix, continued development.

In the Carbonate district the driving of the Carbonate tunnel was continued steadily. The plan is to drain the lower workings of the old Iron Hill mine, a former silver producer.

In the Maitland district development work was continued at the Echo mine.

In the Rawlings district, near Tinton, a small quantity of placer gold was produced from several placers.

PENNINGTON COUNTY.

Nothing but desultory development work was done in the districts of Pennington County.

GOLD, SILVER, AND COPPER IN WYOMING.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

There were only four producing deep mines in Wyoming in 1919, a decrease of eight mines as compared with 1918. There were no producing placer mines in either year.

Mine production of gold, silver, and copper in Wyoming, 1918 and 1919.

Year.	Ore.	Gold.		Silver.		Copper.		Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity	Value.	
	Short tons.	*Fine ounces.*		*Fine ounces.*		*Pounds.*		
1918	2,870	42.14	$871	965	$965	852,777	$210,636	$212,472
1919	798	4.06	84	151	169	139,900	26,021	26,274
Decrease, 1919	2,072	38.08	787	814	796	712,877	184,615	186,198

MINING INDUSTRY.

The only shipments of importance consisted of copper ore from the Sunrise mine, at Hartville.

REVIEW BY COUNTIES.

ALBANY COUNTY.

A small button of gold was recovered during experimental tests at the Fram claim, near Centennial.

The Electrolytic Copper Co. did much development work at its various properties near Foxpark.

Development work was carried on throughout the year at the Native Copper mine, near Tie Siding.

As a result of 10 months' development work in 1919 at the claims of the Colowyo Mining Co., at Centennial, 500 feet of drifts were driven.

CARBON COUNTY.

Several cars of copper ore were shipped from a clean-up of dump material at the Ferris-Haggerty mine, Carbon County.

FREMONT COUNTY.

In the Atlantic City district pumping merely to keep the mine from flooding was continued at the Carissa mine, and some development work was done at the Monte Carlo group.

GOSHEN COUNTY.

In the Muskrat district only assessment work was done.

JOHNSON COUNTY.

Development work was done at the Reliance property, south of Sheridan.

LARAMIE COUNTY.

Some development work was done at the properties of the Eagle Mountain Mining Co., near Hecla.

PLATTE COUNTY.

In the Hartville district several hundred tons of oxidized copper ore, mined in an open pit and hand picked, was shipped from the Sunrise iron mine. A small lot of copper ore was shipped from the Keystone.

IRON ORE, PIG IRON, AND STEEL.[1]

By Ernest F. Burchard.

INTRODUCTION.

The problem that confronted leaders in the iron and steel industry in the United States at the beginning of 1919 was readjustment from war-time to peace-time conditions. That intense and sincere efforts were made and that conditions beyond human control, the aftermath of years of warfare and world-wide in extent, prevented in large measure the accomplishment of the task are matters of history. After the great accomplishments of the American iron and steel industry during the war it was but natural to expect that a large part of the material for the rehabilitation of Europe would be demanded of the United States and that the foreign needs coupled with the domestic shortage would create and sustain even greater activity than during the war. Many conditions were favorable. Capacity for production and shipment of ore and for making pig iron and steel was ample. Armies were no longer being drafted, and soldiers were returning from abroad, many of them without jobs. Handicaps to readjustment and reconstruction were, however, many and far-reaching. Underlying them all in general were the unwillingness of laborers to accept reductions in wages, the unwillingness of manufacturers and distributors to reduce or sacrifice profits in order to build future trade, and the unwillingness of buyers to continue paying what were regarded as war prices. Some small reductions in price were made by general agreement at the end of 1918, and an unsuccessful effort to stabilize steel prices was made by a branch of the Government early in 1919. Domestic buyers, however, were not convinced that prices were right, and European nations, practically commercially insolvent through the depreciation of exchange, sought to rehabilitate their own devastated plants and to manufacture their own supplies, and thus much of the expected foreign buying was not done. Early in the summer of 1919, when it became realized that prices were not going to recede, at least for the time, purchasers who could no longer withstand the necessity for action began to place orders, and soon a good buying movement was under way. At this stage labor difficulties became acute; strikes in coal mines, steel plants, and ore docks threatened to paralyze the iron and steel industry and resulted in a loss of output that could ill be afforded. The year closed with prices high and a shortage of steel. The extent to which the output fell below that of 1918 is indicated in the statistics which follow, iron-ore production having decreased 13 per cent, pig

[1] The statistics in this chapter were compiled by Hubert W. Davis, except those of imports and exports, which were compiled from records of the Bureau of Foreign and Domestic Commerce, Department of Commerce, by J. A. Dorsey, both of the United States Geological Survey.

iron 21 per cent, and steel ingots 22 per cent. Compared with the production of the last pre-war normal year, 1913, the output of iron ore decreased 1.6 per cent and pig iron and steel ingots increased 0.16 per cent and 11 per cent, respectively.

IRON ORE.

IRON ORE MINED AND SHIPPED IN 1919.

The iron ore mined in the United States in 1919, exclusive of that containing 5 per cent or more of manganese,[2] amounted, as shown on page 624 to 60,963,801 gross (long) tons, a decrease of 12.5 per cent. Beneficiated ore, instead of crude ore mined, is included in these figures, if the ore is treated in any way. The quantity of iron ore shipped from the mines in the United States in 1919 amounted to 56,371,167 gross tons, valued at $197,296,282, a decrease in quantity of 22 per cent and in value of 19 per cent, as compared with shipments in 1918. The average price per ton at the mines for all grades of ore for the whole country in 1919 was $3.50, as compared with $3.39 in 1918. These quantities of ore, both mined and shipped, include the iron ore used for fluxing other metallic ores at smelters in the Western States and also ore used for purifying gas and hydrogen manufacture, but the shipments do not include the iron ore sold for the manufacture of paint, which amounted to 15,969 gross tons, valued at $84,630, or $5.30 a ton, in 1919, compared with 8,959 tons, valued at $22,924, or $2.56 a ton, in 1918. In Arkansas one producer shipped 10 tons of loadstone, averaging about 72 per cent of metallic iron, which was sold at a high price to chemical and novelty manufacturers. This shipment is not included in the tabulated statistics of iron ore.

The ore reported as sold for fluxing other than in the manufacture of pig iron amounted to 76,577 gross tons, valued at $209,127, and the ore reported sold for purifying gas and hydrogen manufacture amounted to 5,000 gross tons, valued at $43,185. The domestic iron ore sold for the manufacture of pig iron amounted to 56,289,590 gross tons, valued at $197,043. 970.

IRON ORE MINED AND SHIPPED, BY STATES.

Iron ore was mined in 24 States in 1919, Iowa and Nevada having dropped out since 1918. Of these States, Idaho, Montana, and Utah produced iron ores for flux only; part of the ore produced in Michigan was used for smelter flux; a small quantity of ore from Virginia was used in the manufacture of hydrogen gas; some of the ore from Pennsylvania was used for purifying gas; and the remaining States produced iron ore mainly for use in blast furnaces, except small quantities used for paint from Maryland, Michigan, New York, Pennsylvania, Tennessee, Virginia, and Wisconsin. The rank of the three States producing the largest quantity of iron ore—Minnesota, Michigan, Alabama—remained practically unchanged. The Minnesota iron ranges are producing more iron ore than all the rest of the States

[2] The production of manganiferous iron ore is given in the chapter on manganese and manganiferous ores in Mineral Resources for 1919.

together, having furnished about 60 per cent of the total for the United States in recent years.

IRON-ORE SHIPMENTS.

The following table, showing the iron ore shipped from the mines in 1918 and 1919, by States, is given precedence over the table showing the quantity mined because the table of shipments is the only one in which values are recorded:

Iron ore shipped from mines in the United States, 1918 and 1919, by States.

State.	1918		1919		Increase or decrease in 1919.		Percentage of increase or decrease in 1919.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity.	Value.
Alabama	6,121,087	$15,334,561	4,895,309	$11,954,425	− 1,225,778	−$3,380,136	− 20	− 22
California	3,121	14,683	2,053	13,796	− 1,068	− 887	− 34	− 6
Georgia	262,003	878,612	74,007	294,619	− 187,996	− 583,993	− 72	− 66
Maryland	6,070	23,686	(a)	(a)	(b)	(b)	(b)	(b)
Michigan	17,587,416	65,900,501	12,911,727	49,774,212	− 4,675,689	−16,126,289	− 27	− 24
Minnesota	43,263,240	144,706,532	34,547,356	121,107,247	− 8,715,884	−23,599,285	− 20	− 16
Missouri	71,968	270,337	53,626	223,144	− 18,342	− 47,193	− 25	− 17
New Jersey	375,238	1,945,651	336,629	1,712,255	− 38,609	− 233,396	− 10	− 12
New Mexico	275,266	546,212	224,553	506,538	− 50,713	− 39,674	− 18	− 7
New York	899,970	5,802,870	701,688	4,002,312	− 198,282	− 1,800,558	− 22	− 31
North Carolina	108,332	604,592	58,778	231,530	− 49,554	− 373,062	− 46	− 62
Pennsylvania	515,845	982,173	616,271	1,340,219	+ 100,426	+ 358,046	+ 19	+ 36
Tennessee	408,954	1,184,546	282,988	817,549	− 125,966	− 366,997	− 31	− 31
Utah	52,722	168,438	44,185	177,327	− 8,537	+ 8,889	− 16	+ 5
Virginia	400,135	1,365,582	304,920	1,139,349	− 95,215	− 226,233	− 24	− 17
Wisconsin	1,167,640	3,796,408	881,740	3,253,290	− 285,900	− 543,118	− 24	− 14
Other States c	502,195	842,763	435,337	748,470	− b 72,928	− b 117,979	− b 14	− b 14
	72,021,202	244,368,147	56,371,167	197,296,282	−15,650,035	−47,071,865	− 22	− 19

a Less than three shippers in Maryland in 1919 and permission not granted to publish State total. Figures for this State therefore included in "Other States."

b Decrease for Maryland included with those for "Other States."

c 1918: Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, Texas, Washington, and Wyoming; 1919: Colorado, Connecticut, Idaho, Maryland, Massachusetts, Montana, Texas, Washington, and Wyoming.

IRON ORE MINED, BY VARIETIES, BY STATES, AND BY MINING DISTRICTS.

Iron minerals comprise sulphides, oxides, carbonates, silicates, and phosphates, of which only the oxides and the carbonates are used in the iron and steel industry, except a small quantity of oxide by-products from sulphide ores used in the manufacture of sulphuric acid. The ores of iron are generally classed under the four heads hematite, brown ore, magnetite, and carbonate.[3]

Hematite has always been predominant as an ore of iron, and in 1919 it constituted nearly 95 per cent of the iron ore mined in the United States. Brown ore and magnetite together furnished a little more than 5 per cent of the total. No production of iron carbonate has been reported since 1916.

[3] Notes concerning the composition of these types of ores are given in U. S. Geol. Survey Mineral Resources, 1916, pt. 1, pp. 537–541, 1918.

Iron ore mined in the United States in 1918 and 1919, by States and varieties, in gross tons, with percentage of increase or decrease in 1919.

State.	Hematite.	Brown ore.	Magnetite.	Total quantity.	Percentage of increase or decrease in 1919.
1918.					
Alabama	4,985,557	769,067		5,754,624	
California			3,107	3,107	
Connecticut		12,130		12,130	
Georgia	114,720	149,882		264,602	
Idaho		785		785	
Iowa		7,052		7,052	
Maryland	(a)	a 8,081		8,081	
Massachusetts		8,450		8,450	
Michigan	16,899,341			16,899,341	
Minnesota	41,953,969			41,953,969	
Missouri	56,755	15,953		72,708	
Montana		300	1,115	1,415	
Nevada		20,303		20,303	
New Jersey			423,525	423,525	
New Mexico	750		267,916	268,666	
New York	43,813		862,366	906,179	
North Carolina		47,739	60,593	108,332	
Pennsylvania		3,163	519,437	522,600	
Tennessee	220,849	188,105		408,954	
Utah		42,556	10,166	52,722	
Virginia	81,120	332,928		414,048	
Wisconsin	1,089,351			1,089,351	
Wyoming	447,884			447,884	
Other States b		7,950	1,500	9,450	
	65,894,709	1,613,844	2,149,725	69,658,278	
1919.					
Alabama	4,444,213	608,822		5,053,035	− 12.2
California			2,053	2,053	− 33.9
Connecticut		5,384		5,384	− 55.6
Georgia		71,224		71,224	− 73.1
Idaho		221		221	− 71.8
Maryland	357			357	− 95.6
Massachusetts		9,509		9,509	+ 12.5
Michigan	15,438,930			15,438,930	− 8.6
Minnesota	36,000,626			36,000,626	− 14.2
Missouri	44,867	8,989		53,856	− 25.9
Montana		2,238	1,200	3,438	+143 0
New Jersey			404,428	404,428	− 4.5
New Mexico	c 27,928		c 197,111	225,039	− 16.2
New York	44,150		827,345	871,495	− 3.8
North Carolina		15,295	43,483	58,778	− 45.7
Pennsylvania		10,268	616,899	627,167	+ 20.0
Tennessee	179,370	104,422		283,792	− 30.6
Utah		21,015	23,170	44,185	− 16.2
Virginia	53,281	251,815		305,096	− 26.3
Wisconsin	1,087,247			1,087,247	− .2
Wyoming	398,613			398,613	− 11.0
Other States b		16,578	2,750	19,328	+104.5
	c 57,719,582	1,125,780	c 2,118,439	60,963,801	− 12.5

a Hematite included in brown ore.
b Colorado, Texas, and Washington.
c Some magnetite included with hematite.

Each of the principal iron-mining districts in the United States, except the Adirondack and Birmingham districts, lies in more than one State, and the different varieties of ore are to a large extent locally segregated, so that statistics of production by districts are of more general interest and importance than statistics by States. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 52,392,339 gross tons in 1919, nearly all hematite, compared with 59,779,794 gross tons in 1918. This district mined about 86 per cent of the total ore in 1918 and 1919. The Birmingham district, in north-central Alabama, mined 4,531,032 gross tons of ore, including both hematite and brown ore, in 1919, compared with 5,107,389 tons in 1918. This district

therefore mined a little more than 7 per cent of the total, or a little more than one-twelfth as much as the Lake district in 1919. The Adirondack district, New York, mined 740,315 gross tons of magnetite in 1919, compared with 762,029 tons in 1918.

Iron ore[a] mined in the United States, by mining districts and varieties, in 1918 and 1919, in gross tons.

1918.

District.	Hematite.	Brown ore.	Magnetite.	Total.
Lake Superior[b]	59,779,794	.....	.....	59,779,794
Birmingham	4,763,057	344,332	.....	5,107,389
Chattanooga	516,259	309,268	.....	825,527
Adirondack	.....	.....	762,029	762,029
Northern New Jersey and southeastern New York	.....	.....	523,862	523,862
Other districts	835,599	960,244	863,834	2,659,677
	65,894,709	1,613,844	2,149,725	69,658,278

1919.

District.	Hematite.	Brown ore.	Magnetite.	Total.	Percentage of decrease in 1919.
Lake Superior[b]	52,392,339	.....	.....	52,392,339	12
Birmingham	4,253,167	277,865	.....	4,531,032	11
Chattanooga	350,116	196,822	.....	546,938	34
Adirondack	.....	.....	740,315	740,315	3
Northern New Jersey and southeastern New York	.....	.....	491,458	491,458	6
Other districts	[c] 723,960	651,093	[c] 886,666	2,261,719	15
	[c] 57,719,582	1,125,780	[c] 2,118,439	60,963,801	12

[a] Exclusive of ore containing 5 per cent or more of manganese.
[b] Includes only those mines in Wisconsin which are in the true Lake Superior district
[c] Some magnetite included with hematite.

TOTAL OUTPUT OF IRON ORE.

The following table shows the production of various types of iron ore in the United States as far as it has been recorded or estimated. The figures for the years prior to 1880 were calculated from the pig iron produced, which included imported ore as well as domestic ore.

Iron ore mined in the United States, 1810–1919, in gross tons.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	Total.
1810–1869	.....	.....	.....	.....	49,656,000
1870[a]–1880	.....	.....	.....	.....	51,690,889
1881–1890	.....	.....	.....	.....	103,854,386
1891–1900	136,961,046	22,845,764	14,634,364	1,065,137	175,506,311
1901–1910	364,179,432	[b]28,287,994	[b]20,664,453	262,366	413,394,245
1911	39,626,224	2,032,094	2,202,527	15,707	43,876,552
1912	51,345,782	1,614,486	2,179,533	10,346	55,150,147
1913	57,933,251	1,682,063	2,357,274	7,849	61,980,437
1914	38,286,670	1,537,750	1,610,203	5,138	41,439,761
1915	52,227,324	1,488,709	1,807,002	3,455	55,526,490
1916	70,728,024	1,904,484	2,533,364	1,800	75,167,672
1917	70,743,513	1,992,332	2,553,006	.....	75,288,851
1918	65,894,709	1,613,844	2,149,725	.....	69,658,278
1919	[c]57,719,582	1,125,780	[c] 2,118,439	.....	60,963,801
	.....	.....	.....	.....	1,333,153,820

[a] Includes ore produced by owners of blast furnaces estimated by census at 800,000 tons.
[b] Some brown ore included in magnetite.
[c] Some magnetite included in hematite.

STOCK OF IRON ORE AT MINES.

According to the reports of producers, a few of which have been revised since the report for 1918 was published, the total quantity of iron ore in stock at the mines at the end of 1919 amounted to 13,097,500 gross tons, compared with 8,565,893 tons at the end of 1918, an increase of nearly 53 per cent. As the quantity of ore in stock piles is necessarily partly estimated, there are variations in the mine reports from year to year which prevent an absolute balance between the quantity mined and the quantity sold plus stocks on hand. Certain stocks of iron ore in Ohio, which are at present non-commercial, have been disregarded in compiling the following table:

Stock of iron ore at mines, by States, Dec. 31, 1918 and 1919, in gross tons.

State.	1918	1919	State.	1918	1919
Alabama	242,781	402,647	New Jersey	205,756	267,162
Georgia	10,025	7,042	New Mexico	.....	486
Iowa	12,165	12,165	New York	35,049	203,267
Maryland	4,141	2,140	Pennsylvania	41,593	45,500
Massachusetts	1,172	3,960	Virginia	44,527	44,315
Michigan	4,368,909	6,874,604	Wisconsin	232,250	431,312
Minnesota	3,365,540	4,801,460			
Missouri	1,985	1,440		8,565,893	13,097,500

PRICES OF IRON ORE PER TON.

In the following table the average price per ton at the mines of the different classes of iron ore in 1918 and 1919 is given for each of the producing States or groups of States, except where there were less than three producers or shippers of a certain variety of ore in a State and permission was not given to publish the prices. These figures are taken directly from statements of the producers and probably represent only approximately the actual selling prices. By far the greater bulk of the iron ore produced in the United States is mined by iron and steel producers for their own furnaces, and the value placed on such ore is therefore largely a matter of accounting. Some of the reports made to the Survey evidently include merely mining costs; others contain, in addition, the cost of selling and insuring the ore; in others an allowance for sinking fund is included; and in still others the figures given are the prices used in charging costs against the blast furnaces; none of them include freight costs.

Average price per gross ton of iron ore in the United States in 1918 and 1919.

State.	Hematite.		Brown ore.		Magnetite.	
	1918	1919	1918	1919	1918	1919
Alabama	$2.36	$2.29	$3.55	$3.52	.....	.....
California	.....	.....	.....	.....	$4.70	$6.72
Georgia	2.59	.....	3.92	3.98	.....	.....
Maryland	(a)	.....	3.67	(a)	.....	.....
Michigan	3.75	3.85	.....	.....	.....	.....
Minnesota	3.34	3.51	.....	.....	.....	.....
Missouri	3.84	4.03	3.46	4.85	.....	.....
New Jersey	.....	.....	.....	(a)	5.19	5.08
New Mexico	(a)	(a)	.....	.....	1.98	(a)
New York	(a)	(a)	.....	.....	6.60	5.85
North Carolina	.....	.....	3.26	3.51	(a)	(a)
Pennsylvania	.....	.....	(a)	(a)	(a)	2.13
Tennessee	2.43	(a)	3.44	3.08	.....	.....
Utah	.....	.....	3.03	(a)	(a)	(a)
Virginia	3.84	3.84	3.30	3.71	.....	.....
Wisconsin	3.25	3.69	.....	.....	.....	.....
Other States[b]	1.40	1.48	3.92	4.17	1.91	2.58
Total average	3.35	3.48	3.51	3.62	4.60	4.08

[a] Less than three producers and permission to publish not given; therefore price may not be shown.
[b] 1918: Colorado, Connecticut, Idaho, Massachusetts, Montana, Nevada, Pennsylvania, Texas, Washington, and Wyoming; 1919: Colorado, Connecticut, Idaho, Maryland, Massachusetts, Montana, New Mexico, Texas, Utah, Washington, and Wyoming.

Average price per gross ton of iron ore in the United States, 1889, 1892–1919.

Year.	Hematite.	Brown ore.	Magnetite.	Carbonate.	General average.
1889	.....	.....	.....	.....	$2.30
1892	.....	.....	.....	.....	2.04
1893	.....	.....	.....	.....	1.66
1894	.....	.....	.....	.....	1.14
1895	.....	.....	.....	.....	1.14
1896	.....	.....	.....	.....	1.42
1897	.....	.....	.....	.....	1.08
1898	.....	.....	.....	.....	1.14
1899	.....	.....	.....	.....	1.42
1900	.....	.....	.....	.....	2.42
1901	.....	.....	.....	.....	1.71
1902	.....	.....	.....	.....	1.84
1903	.....	.....	.....	.....	1.89
1904	.....	.....	.....	.....	1.56
1905	.....	.....	.....	.....	1.77
1906	$2.13	$1.78	$2.05	$1.75	2.11
1907	2.03	1.81	2.03	1.74	2.55
1908	2.32	1.70	2.40	1.38	2.27
1909	2.17	1.68	2.40	1.73	2.15
1910	2.52	1.76	2.36	1.61	2.47
1911	2.12	1.72	2.29	1.83	2.11
1912	1.87	1.79	2.18	1.96	1.88
1913	2.21	1.88	2.07	2.06	2.19
1914	1.79	1.72	2.39	2.44	1.81
1915	1.80	1.80	2.50	2.44	1.83
1916	2.32	2.03	3.11	3.00	2.34
1917	3.12	2.95	4.29	.....	3.15
1918	3.35	3.51	4.60	.....	3.39
1919	3.48	3.62	4.08	.....	3.50

APPARENT CONSUMPTION OF IRON ORE COMPARED WITH PRODUCTION OF PIG IRON AND FERROALLOYS.

The following table includes data on certain items from which an approximate estimate of the annual consumption of iron ore in the United States is deduced, though no data are available on certain other items, such as stocks at furnaces, which should enter into the final result. The items considered in the table and in the annual estimates are (1) domestic iron ore shipped; (2) production of zinc residuum; (3) imports of ore; (4) exports of ore. The shipments of ore and zinc residuum plus the imports of ore represent the available supply, which, less the exports, gives the apparent domestic consumption, without consideration of the stocks at mines and at Lake ports. This apparent consumption includes small quantities of ore not used in the manufacture of pig iron, such as ore consumed in the open-hearth steel furnaces and in smelting gold, silver, and copper; but it does not include ore used in the manufacture of paint.

In the same table are given the production of pig iron, including ferromanganese, spiegeleisen, ferrosilicon, and other ferroalloys, for corresponding years and the ratio of pig iron and ferroalloys produced to iron ore consumed. On later pages of the report will be found detailed statistics on the production and shipments of pig iron.

The ratio of pig iron manufactured to iron ore consumed was 55.45 per cent in 1919, as compared with 54.47 per cent in 1918. From 1889 to 1910 the ratio ranged from 49.42 per cent to 61.33 per cent, with an average of 52.38 per cent.

Apparent consumption of iron ore compared with production of pig iron and ferroalloys in the United States, 1911–1919, in gross tons.

Year.	Domestic iron ore shipped.[a]	Zinc residuum.	Imports.	Exports.	Apparent consumption.	Pig iron produced.[b]	Percentage ratio of pig iron to iron ore.
1911	41,092,447	109,296	1,811,732	768,386	42,245,089	23,649,547	55.98
1912	57,017,614	104,670	2,104,576	1,195,742	58,031,118	29,726,937	51.23
1913	59,643,098	102,239	2,594,770	1,042,151	61,297,956	30,966,152	50.52
1914	39,714,280	100,198	1,350,588	551,618	40,613,448	23,332,244	57.45
1915	55,493,100	159,318	1,341,281	707,641	56,286,058	29,916,213	53.15
1916	77,870,553	198,817	1,325,736	1,183,952	78,211,154	39,434,797	50.42
1917	75,573,207	155,332	971,663	1,132,313	75,567,889	38,621,216	51.11
1918	72,021,202	146,796	787,468	1,256,383	71,699,083	39,054,644	54.47
1919	56,371,167	80,418	476,461	996,569	55,931,477	31,015,364	55.45

[a] Iron ore sold for paint excluded and included in metallic paint.

[b] From annual reports of the American Iron and Steel Association prior to 1912, and including ferroalloys produced in blast furnaces; beginning with 1912, according to American Iron and Steel Institute, and also including ferroalloys.

The figures of consumption of ore as reported directly to the Survey by the manufacturers of iron are of interest in comparison with the figures in this table. Prior to 1915 such data were not sufficiently complete for publication, but in connection with the statistics of the value of pig iron, which are collected only by the United States Geological Survey, it has been found necessary to gather related data, some of which are now sufficiently complete for presentation in the following table:

Iron ore and accessory materials consumed in the manufacture of pig iron, 1915–1919.

Year.	Metalliferous materials consumed (gross tons).				Pig iron produced, exclusive of ferroalloys (gross tons).			Percentage ratio of pig iron to materials consumed.		
	Iron ore.		Miscellaneous [a] domestic and foreign.	Total.	From domestic materials.	From foreign materials.	Total.	Domestic.	Foreign.	Total.
	Domestic.	Foreign.								
1915	53,775,945	1,381,484	251,593	55,409,022	28,646,349	910,595	29,556,944	53.02	65.91	53.34
1916	70,769,337	1,295,518	4,036,022	76,100,877	37,974,413	727,550	38,701,963	50.76	56.16	50.86
1917	69,108,181	749,174	5,647,723	75,505,078	37,437,929	486,561	37,924,490	50.19	53.31	50.22
1918	69,905,547	690,145	5,343,963	75,939,655	37,679,786	451,000	38,130,786	50.13	57.86	50.21
1919	54,950,623	520,785	3,721,448	59,192,856	30,200,511	307,611	30,508,122	51.48	58.42	51.54

[a] Pyrite cinder, scrap, mill cinder, and scale.

IRON-ORE INDUSTRY IN THE LAKE SUPERIOR DISTRICT.

PRODUCTION.

The ranges in the United States portion of the Lake Superior district that produced ore in 1919 were the Marquette, Menominee, Gogebic, Vermilion, Mesabi, and Cuyuna, besides the Baraboo and Iron Ridge areas. The output of the Cuyuna range, as in 1917 and 1918, surpassed that of the Vermilion range.

The total quantity of ore mined from the Lake Superior district, excluding the Baraboo and Iron Ridge areas, decreased 12 per cent in 1919. The output of the different ranges is shown below. All ore containing more than 5 per cent of manganese is excluded. The production of manganiferous iron ore from the Cuyuna range is reported in the chapter on manganese and manganiferous ores in Mineral Resources for 1919. The Mesabi range produced 64 per cent of the entire output of the Lake Superior district and nearly 55 per cent of the entire production of the United States.

Iron ore mined in the Lake Superior district,[a] 1918 and 1919, in gross tons.

Range.	1918	1919	Increase or decrease in 1919.	Percentage of increase or decrease, 1919.	Percentage of total output, 1919.	
					Lake Superior district.	United States.
Marquette (Michigan)	3,946,554	4,158,751	+ 212,197	+ 5	8	6.8
Menominee (Michigan and Wisconsin)	6,041,637	4,863,968	−1,177,669	−19	9	8.0
Gogebic (Michigan and Wisconsin)	7,837,634	7,368,994	− 468,640	− 6	14	12.0
Vermilion (Minnesota)	1,192,677	1,051,795	− 140,882	−12	2	1.7
Mesabi (Minnesota)	39,055,977	33,262,954	−5,793,023	−15	64	54.6
Cuyuna (Minnesota)	1,705,315	1,685,877	− 19,438	− 1	3	2.8
	59,779,794	52,392,339	−7,387,455	−12	100	85.9

[a] Includes only such Wisconsin mines as are in the true Lake Superior district.

Iron ore mined in the Lake Superior district, 1854–1919, by ranges, in gross tons.

Year.	Marquette.	Menominee.	Gogebic.	Vermilion.	Mesabi.	Cuyuna.	Total.
1854–1870	3, 971, 716	.....	.....	.....	.....	.....	3, 971, 716
1871–1880	10, 294, 047	858, 810	.....	.....	.....	.....	11, 152, 857
1881–1890	18, 598, 012	11, 917, 416	8, 657, 807	3, 260, 426	.....	.....	42, 433, 661
1891–1900	27, 269, 545	21, 639, 872	23, 361, 043	12, 097, 048	32, 282, 873	.....	116, 650, 381
1901–1910	37, 728, 143	41, 974, 789	34, 514, 899	15, 350, 581	194, 654, 902	.....	324, 223, 314
1911	3, 743, 145	4, 062, 778	3, 099, 197	1, 336, 938	23, 126, 943	181, 224	35, 550, 225
1912	3, 545, 012	4, 465, 466	3, 926, 632	1, 457, 273	32, 604, 756	369, 739	46, 368, 878
1913	3, 977, 808	4, 997, 246	4, 743, 515	1, 536, 115	36, 378, 671	744, 007	52, 377, 362
1914	3, 320, 763	3, 671, 499	4, 601, 240	1, 362, 416	19, 808, 434	776, 051	33, 540, 403
1915	3, 817, 892	4, 665, 465	4, 996, 237	1, 541, 645	30, 802, 409	1, 120, 606	46, 944, 254
1916	4, 792, 987	6, 649, 578	7, 707, 101	1, 704, 440	41, 325, 341	1, 555, 641	63, 735, 088
1917	4, 638, 374	6, 366, 483	7, 881, 232	1, 481, 301	41, 127, 323	1, 986, 608	63, 481, 321
1918	3, 946, 554	6, 041, 637	7, 837, 634	1, 192, 677	39, 055, 977	1, 705, 315	59, 779, 794
1919	4, 158, 751	4, 863, 968	7, 368, 994	1, 051, 795	33, 262, 954	1, 685, 877	52, 392, 339
	133, 802, 749	122, 175, 007	118, 695, 531	43, 372, 655	524, 430, 583	10, 125, 068	952, 601, 593

SHIPMENTS AND RECEIPTS.

According to the Iron Trade Review, 48,546,651 gross tons of iron ore was shipped in 1919 from the Lake Superior district, including the Iron Ridge and Baraboo areas in Wisconsin. The shipments as reported to the Geological Survey in 1919 amounted to 48,340,823 gross tons, exclusive of manganiferous iron ore containing 5 per cent or more of manganese, compared with 62,018,296 tons in 1918.

Iron ore shipped from the Lake Superior district, 1915–1919, by ports, in gross tons.[a]

Shipping port.	1915	1916	1917	1918	1919
Escanaba, Mich	5, 649, 289	7, 457, 444	7, 156, 854	6, 774, 969	4, 963, 358
Marquette, Mich	3, 099, 589	3, 858, 092	3, 207, 145	3, 457, 054	2, 132, 935
Ashland, Wis	5, 146, 772	8, 057, 814	7, 597, 841	7, 565, 608	5, 915, 383
Two Harbors, Minn	8, 642, 942	10, 735, 853	9, 990, 901	8, 723, 472	6, 424, 545
Superior, Wis	8, 342, 793	12, 787, 046	13, 978, 741	14, 068, 341	10, 919, 965
Duluth, Minn	15, 437, 419	21, 837, 949	20, 567, 419	20, 567, 288	16, 821, 209
Total by lake	46, 318, 804	64, 734, 198	62, 498, 901	61, 156, 732	47, 177, 395
Total by rail	953, 947	1, 924, 268	1, 938, 102	1, 679, 440	1, 369, 256
	47, 272, 751	66, 658, 466	64, 437, 003	62, 836, 172	48, 546, 651

[a] Iron Trade Review.

Iron ore shipped from the Lake Superior district, 1915–1919, by months, in gross tons.[a]

Month.	1915	1916	1917	1918	1919
April	503, 832	1, 658, 411	211, 532	235, 870	1, 412, 239
May	5, 012, 359	8, 449, 580	6, 283, 612	8, 792, 231	6, 615, 341
June	6, 005, 091	9, 507, 576	9, 639, 991	9, 921, 860	7, 980, 839
July	7, 204, 020	9, 750, 157	10, 241, 633	10, 659, 203	9, 173, 429
August	8, 081, 117	9, 850, 140	10, 146, 786	9, 725, 331	4, 423, 133
September	7, 863, 146	9, 600, 786	9, 536, 152	8, 995, 014	8, 178, 483
October	7, 146, 873	9, 116, 196	8, 193, 892	8, 541, 593	6, 201, 883
November	4, 445, 129	5, 715, 452	7, 333, 828	4, 279, 025	3, 152, 319
December	57, 236	1, 085, 900	911, 475	6, 836	46, 662
Total by lake [b]	46, 318, 804	64, 734, 198	62, 498, 901	61, 156, 732	47, 177, 395
Total by rail	953, 947	1, 924, 268	1, 938, 102	1, 679, 440	1, 369, 256
	47, 272, 751	66, 658, 466	64, 437, 003	62, 836, 172	48, 546, 651

[a] Iron Trade Review.
[b] Totals by seasons will be found to vary slightly from the sums of the monthly movements because of corrections.

Iron ore received at Lake Erie ports, 1915–1919, in gross tons.[a]

Port.	1915	1916	1917	1918	1919
Toledo	1,158,374	2,035,160	2,445,602	2,608,497	1,536,437
Huron	695,865	1,324,112	1,631,395	1,620,712	1,134,104
Lorain	3,517,258	4,613,929	3,831,244	3,494,370	3,379,421
Cleveland	7,504,697	10,669,745	9,077,161	9,681,882	7,466,921
Fairport	2,001,103	2,580,647	2,311,179	1,853,465	1,952,635
Ashtabula	7,813,101	11,474,268	10,251,304	11,001,574	8,377,277
Conneaut	8,573,509	9,588,341	8,729,754	6,650,898	7,056,882
Erie	707,875	1,525,031	2,079,227	1,809,619	1,102,478
Buffalo	5,339,724	7,432,220	7,843,215	8,845,775	4,649,008
Detroit	459,877	425,579	418,151	444,936	549,096
Port Colborne, Ontario, Canada	196,077	138,240	194,627	171,287	219,326
	37,967,460	51,807,272	48,812,859	48,183,015	37,423,585

[a] Iron Trade Review.

The difference between the shipments of Lake Superior ore and the receipts of Lake Erie ports is accounted for in large part by the quantity of ore delivered at Lake Michigan ports, South Chicago, Ill., Gary and Indiana Harbor, Ind., and Milwaukee, Wis. The receipts at those ports and at smaller places are shown in the following table. It is understood that there is also a loss, probably less than 1 per cent, in handling ore between mines and lower Lake ports.

Iron ore received at Lake Michigan ports, 1915–1919, in gross tons.[a]

Port.	1915	1916	1917	1918	1919
East Jordan, Mich.	37,658	38,573	35,792	33,940	32,706
Milwaukee, Wis.	187,286	239,219	224,570	166,626	133,220
Gary, Ind.	2,421,924	2,718,185	3,883,082	3,848,295	2,509,338
Indiana Harbor, Ind.	689,226	793,215	900,692	1,413,392	1,150,683
South Chicago, Ill.	4,195,976	7,740,877	7,030,174	6,113,492	4,670,054
Boyne City, Mich.	40,401	43,788	44,437	34,137	47,061
	7,572,471	11,573,857	12,118,747	11,609,882	8,543,062

[a] Iron Trade Review.

The following table shows the total quantity of iron ore shipped from the Lake Superior district since 1854, the date of the opening of the Marquette range, the oldest of the Lake Superior ranges. This table gives the shipments as published by the Iron Trade Review and is inserted for comparison with the table giving the total production of the Lake Superior district, without regard to shipments. Later tables show the uniformity with which stocks of iron ore were maintained at the close of navigation at the lower Lake ports during war years and the balances remaining at these ports at the opening of navigation the following spring seasons.

Iron ore shipped from the Lake Superior district, 1854–1919, in gross tons.[a]

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1854–1860	265,547	1911	32,793,130	1917	64,437,003
1861–1870	3,548,664	1912	48,221,546	1918	62,836,172
1871–1880	11,057,177	1913	49,947,116	1919	48,546,651
1881–1890	42,277,694	1914	32,729,726		
1891–1900	114,110,586	1915	47,272,751		946,236,103
1901–1910	321,533,874	1916	66,658,466		

[a] Iron Trade Review.

STOCKS OF IRON ORE AT LAKE ERIE PORTS.

Stocks of iron ore at Lake Erie ports, Dec. 1, 1915–1919, in gross tons.[a]

Port.	At close of navigation, Dec. 1—				
	1915	1916	1917	1918	1919
Toledo, Ohio	311,799	394,869	399,479	399,839	332,051
Sandusky, Ohio	1,871				
Huron, Ohio	558,692	590,743	556,765	607,233	698,927
Lorain, Ohio	824,988	1,076,105	978,108	828,384	777,803
Cleveland, Ohio	1,795,962	1,936,906	1,914,071	2,117,176	2,078,201
Fairport, Ohio	413,994	474,930	536,580	510,855	528,360
Ashtabula, Ohio	2,870,204	3,266,752	3,435,624	3,292,738	3,429,258
Conneaut, Ohio	1,216,686	1,363,550	1,544,706	1,703,701	1,850,759
Erie, Pa	589,355	625,193	519,698	439,094	405,761
Buffalo, N. Y	326,800	438,712	441,318	525,947	355,194
	8,910,351	10,167,760	10,326,349	10,424,967	10,456,314

[a] Iron Trade Review.

Stocks of iron ore at Lake Erie ports May 1, 1916–1920, in gross tons.[a]

Port.	At opening of navigation, May—				
	1916	1917	1918	1919	1920
Toledo, Ohio	164,637	257,030	230,797	241,965	156,644
Huron, Ohio	286,054	333,124	387,042	429,200	568,790
Lorain, Ohio	173,771	503,618	475,137	190,003	407,094
Cleveland, Ohio	772,721	970,973	933,687	1,259,120	1,412,757
Fairport, Ohio	198,636	237,645	329,528	326,621	347,042
Ashtabula, Ohio	1,176,142	1,660,818	1,744,448	1,740,072	1,880,198
Conneaut, Ohio	41,080	183,255	844,447	731,503	954,783
Erie, Pa	312,866	406,078	363,008	369,978	265,359
Buffalo, N. Y	187,498	219,691	313,925	392,623	199,434
	3,343,405	4,772,232	5,622,019	5,681,085	6,192,101

[a] Marine Review.

MINING DEVELOPMENTS.

Ore-mining developments in the Lake Superior iron-mining districts are discussed in articles published at the beginning of 1920.[4] Despite the unsatisfactory conditions that attended operations, there proved to be interesting features in connection with iron mining in 1919. The unsatisfactory labor situation seems to be permanent; each year finds the supply scant and inefficient and wages high out of all proportion to service rendered. Natural conditions, such as bad weather on land and water, retarded mining and shipping of ore; increasing depth to ore bodies increased costs and difficulties of mining—nevertheless new records were made in stripping operations, at one deposit thicknesses of 130 to 150 feet being stripped in order to obtain ore 60 feet thick. Where the depth of pits became too great for further operation of locomotive-drawn trains up the steep grades, mines have passed into the underground system. Another natural cause that has tended to increase the cost of ore is the decrease in percentage of iron in Mesabi ores, resulting either in

[4] Woodbridge, D. E., Striking features of Lake Superior mining: Iron Age, Jan. 1, 1920, pp. 66–69. Hain, A. J., Developments on the ranges: Iron Trade Rev., Jan. 1, 1920, pp. 70–78.

the necessity of shipping lower-grade ore or of subjecting the ore to concentration; thus the scope of beneficiation of ores has continued to expand, and in 1919 several new plants were erected with slight variations in method from those already in use. Royalties continued to increase, expiring leases that had been signed at 25 cents a ton having been renewed at 75 to 85 cents. Measures for conservation of ore through more economical methods of mining and by mixing richer with leaner ore so as to eliminate waste are being insisted upon by fee owners, including the State of Minnesota.

A large part of the town of Hibbing, on the Mesabi range, was being moved to a new site about 2 miles distant in order to permit the winning of an ore body underlying 40 acres in the northern part of the town. In this way the town gains a more spacious site, a fine hospital, several new store buildings, and a hotel through the liberality of the mining company concerned.

On the Vermilion and Gogebic ranges there were explorations for deep ore bodies, and on the Gogebic range considerable rock stripping has been done in order to develop open-pit mines. Hydroelectric power was brought to several mines in northern Michigan.

Improvements in equipment included installation of larger steam shovels in the open pits and of mechanical loaders underground. The large steam shovels have dippers of 7 to 8 cubic yards capacity, compared with those of 3 to 4 yards of a few years ago. The larger shovels are capable of making cuts 45 feet high and loading on the top of the cut, as contrasted with cuts 30 feet high and loading on the level of the floor of the cut, as formerly. A much longer cut is also possible, and a great saving is effected in track laying by use of the maximum-size shovels.

With cessation in demand for manganese after the armistice was signed many of the mines on the Cuyuna range producing manganiferous iron ore were forced to close or greatly to curtail operations. Attempts to wash certain of the sandy ores have not proved successful, so that on the whole the Cuyuna range suffered greater disappointments in 1919 than the other iron-producing districts.

The most noteworthy progress in facilities for the transportation of ore in the Lake Superior district was the completion of the new ore dock of the Duluth, Missabe & Northern Railway at Duluth. This dock, which is the largest in the world, is reported to have cost $3,500,000 and to have a storage capacity of 153,600 tons or 3,072 carloads of 50 tons each. Its length is 2,438 feet, sufficient to accommodate on each side, end to end, two of the world's largest ships.

IRON-ORE RESERVES.

Estimates of ore reserves for Minnesota, furnished by Rukard Hurd, director of mines of the Minnesota Tax Commission, and for Michigan, furnished by R. A. Smith, State geologist, including developed and prospective ore in the ground and ore in stock piles, show decreases in both States—not quite 38,000,000 tons in Minnesota, and nearly 5,000,000 tons in Michigan. The reserves in all three producing ranges in Minnesota decreased; in Michigan the decrease was in the Menominee range, the Gogebic and Marquette ranges having shown increases, due to active prospecting.

Iron-ore reserves in Minnesota, May 1, 1916, 1917, 1918, and 1919, in gross tons.

Range.	1916	1917	1918	1919
Mesabi	1,384,635,891	1,381,754,428	1,362,277,471	1,328,821,214
Vermilion	13,058,280	11,961,684	12,251,025	11,621,197
Cuyuna	77,926,062	70,159,848	63,208,588	59,393,443
	1,475,620,233	1,463,875,960	1,437,737,084	1,399,835,854

Iron-ore reserves in Michigan, Jan. 1, 1917, 1918, 1919, and 1920, in gross tons.

Range.	1917	1918	1919	1920
Gogebic	47,152,084	55,813,661	63,497,143	64,563,003
Marquette	79,624,681	78,175,301	64,254,626	70,114,034
Menominee (including Iron River and Crystal Falls districts)	69,696,046	66,154,547	75,819,940	63,929,438
	196,472,811	200,143,509	203,571,709	198,606,475

FOREIGN TRADE IN IRON ORE.

IMPORTS.

The iron ore imported into the United States in 1919 decreased 39 per cent in quantity and 31 per cent in value, as compared with the imports during 1918. The average value was $5.01 a ton in 1919 and $4.40 in 1918. Cuba produced 68 per cent of the ore imported, Spain 13 per cent, Sweden 13 per cent, Canada nearly 3 per cent, and Norway, France, British West Africa, the United Kingdom, Mexico, and Brazil the rest. The accompanying diagram (fig. 9) indicates the source and destination of the iron ore imported into the United States.

Iron ore imported into the United States, 1917–1919.

Country.	1917		1918		1919	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Cuba	546,069	$1,728,437	632,442	$2,376,399	321,753	$1,221,949
Spain	152,713	582,644	38,385	458,234	63,737	592,096
French Africa	8,860	22,212				
United Kingdom	4,717	133,004	82	524	180	4,380
Canada	195,588	850,153	115,354	611,072	12,383	64,785
Sweden	63,715	338,936			61,540	384,067
France			1,205	18,075	6,376	57,000
Norway	1	6			6,426	35,000
Mexico					75	392
Brazil					10	20
British West Africa					3,981	26,000
	971,663	3,655,392	787,468	3,464,304	476,461	2,385,689

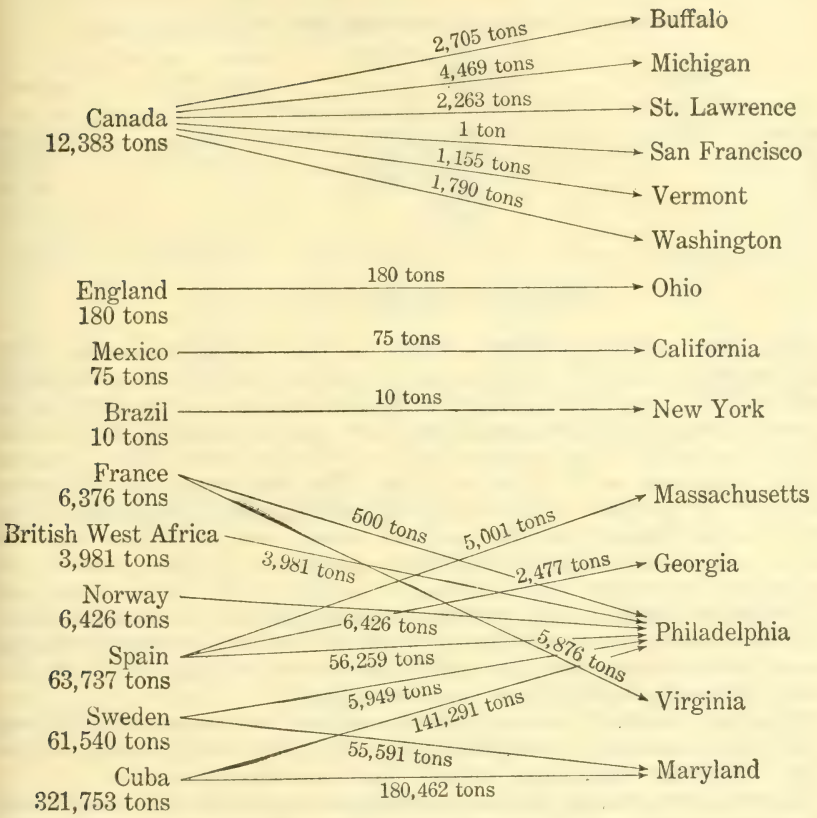


FIGURE 9.—Source and destination of iron ore imported into the United States in 1919.

In the following table are shown the imports of iron ore into the United States as far as recorded. Iron ore was imported from Europe in large quantities for the first time in 1879, most of the imports prior to that date coming from Canada.

Iron ore imported into the United States, 1872–1919, in gross tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1872–1880	1,188,267	1912	2,104,576	1917	971,663
1881–1890	7,663,630	1913	2,594,770	1918	787,468
1891–1900	5,869,757	1914	1,350,588	1919	476,461
1901–1910	11,798,568	1915	1,341,281		
1911	1,811,732	1916	1,325,736		39,284,497

EXPORTS.

The quantity of iron ore exported from the United States in 1919 amounted to 996,569 gross tons, valued at $4,308,746, or $4.32 a ton, as compared with 1,256,383 gross tons, valued at $5,535,090, or $4.41 a ton, in 1918. This represents a decrease of 21 per cent in quantity and 22 per cent in value, compared with 1918. Practically all the ore exported in 1919 went to Canada.

Iron ore exported from the United States, 1899–1919, in gross tons.

Year.	Quantity.	Year.	Quantity.
1899–1900	92,125	1916	1,183,952
1901–1910	2,713,397	1917	1,132,313
1911	768,386	1918	1,256,383
1912	1,195,742	1919	996,569
1913	1,042,151		
1914	551,618		11,640,277
1915	707,641		

IRON-ORE INDUSTRY OF CUBA.

The iron ore shipped from Cuba to the United States in 1919 amounted to 357,780 gross tons, valued at $1,075,828, compared with 643,532 gross tons, valued at $2,096,761, in 1918, a decrease in quantity of 285,752 tons, or 44 per cent, and in value of $1,020,933, or 49 per cent. The average price of the ore was $3.01 a ton in 1919, compared with $3.26 in 1918. The shipments in 1919 consisted of 78 per cent of hematite, including a little magnetite, from the Daiquiri mines, on the southern coast, and of 22 per cent of brown ore from the Mayari mines, near the northern coast. In 1919 the iron content of the hematite, dried at 212° F., was reported at 58.09 per cent, and the brown ore carried 48.10 per cent (natural) and 55.83 per cent (nodulized); in 1918 hematite (natural) ranged from 53.95 to 57.8 per cent, and the brown ore carried 48.08 per cent (natural) and 56.77 per cent (nodulized).

The total stock of ore reported as on hand at the end of 1919 was 1,232,187 gross tons, compared with 1,263,595 tons at the end of 1918. This included both natural and nodulized ore.

The following table shows the shipments of iron ore from Cuba since the opening of the mines in 1884. The curtailment of the production of iron ore in Cuba as a result of the World War is shown by these statistics. The sudden depression in the iron industry in 1914 reduced the output of Cuban ore about 48 per cent, as compared with 1913. In 1915 the output was about the same as in 1914, but in 1916, 1917, 1918, and 1919 the output was further restricted by the shortage of ships, notwithstanding the great need for these excellent and easily accessible ores at iron and steel plants on the eastern seaboard of the United States. The shipments in 1919 were the lowest since 1898. The statistics of the shipments of Cuban iron ore are collected by the United States Geological Survey.

Iron ore shipped from mines in the Province of Oriente, Cuba, 1884–1919, in gross tons.

Year.	Juragua Iron Co. (Ltd.) (hematite and magnetite).	Sigua Iron Co. (hematite).	Spanish-American Iron Co.		Cuban Steel Ore Co. (hematite).	Ponupo Manganese Co., El Cuero iron mines (hematite).	Total.
			Daiquiri mines (hematite and a little magnetite).	Mayari mines (brown ore).			
1884–1890	1,142,519	.....	.....	.....	.....	.....	1,142,519
1891–1900	[a] 2,348,473	20,438	[b] 979,992	.....	.....	.....	3,348,903
1901–1910	2,104,186	.....	[c] 4,456,440	507,700	41,241	224,729	7,134,296
1911	355,132	.....	252,717	387,791	.....	168,074	1,163,714
1912	360,094	.....	463,533	446,176	.....	127,994	1,397,797
1913	369,213	.....	591,322	491,713	.....	130,183	1,582,431
1914	267,641	.....	284,507	228,949	.....	40,013	821,110
1915	215,032	.....	245,590	300,896	.....	65,930	827,448
1916	212,013	.....	181,602	258,451	.....	60,650	712,716
1917	39,784	.....	181,028	287,904	.....	44,769	553,485
1918	17,128	.....	353,103	232,540	.....	40,761	643,532
1919	.....	.....	279,700	78,080	.....	.....	357,780
	7,431,215	20,438	8,269,534	3,020,200	41,241	903,103	19,685,731

[a] Of this quantity, 5,932 tons was sent to Pictou, Nova Scotia.
[b] Of this quantity, 51,537 tons was sent to foreign ports.
[c] Of this quantity, 12,691 tons was sent to foreign ports.

BENEFICIATED IRON ORE.

The processes reported as employed in 1919 to improve the quality of the ore at various mines were crushing and screening, drying by direct heat and by steam, hand picking on tables and on belts, washing by means of hydraulic jets and logs, jigging, electromagnetic cobbing, other concentration and separation, calcining, nodulizing, and desulphurization by sintering. Some of the operations combined two or more of these processes. Iron ores were reported as beneficiated at 93 mines in 14 States in 1919 and at 101 mines in 15 States in 1918, and in both years at the brown-ore mines of the Spanish-American Iron Co. in the Mayari district, Cuba. In addition to these processes some iron ore is recovered in the form of blast-furnace ore dust, but no statistics have been gathered on this subject. Ore so recovered has been originally accounted for in the statistics of shipments from the mines.

In Alabama the ore treated was principally brown ore, and the usual processes to which it was subjected were log washing, screening, and picking on belts. A total of 862,843 gross tons of beneficiated ore, valued at $2,821,857, was marketed from 24 mines in Alabama in 1919, compared with 986,630 tons, valued at $3,323,329, from 25 mines in 1918.

One mine in Connecticut, seven in Georgia, and one in Massachusetts reported the concentration of brown ore in 1919.

Hematite was beneficiated at two mines in Michigan and at twenty mines in Minnesota in 1919. Washing, screening, and drying were the principal processes employed.

Seven mines reported magnetic concentration of magnetite in New Jersey, at two of which dry tables were employed in addition and at one roasting was also employed; at one brown-ore mine crushing, washing, and magnetic separation were reported. Magnetite was treated by jigging at one mine in New Mexico. At one

mine in North Carolina, which produced magnetite, the ore was subjected to a rough concentration consisting of electromagnetic cobbing, and four mines reported washing of brown ore in 1919.

In New York beneficiation of magnetite was reported by six mines. The magnetite was mainly concentrated magnetically. The total shipments of beneficiated ore in New York amounted to 444,336 gross tons, valued at $2,721,440, in 1919, compared with 716,378 gross tons, valued at $4,840,642, in 1918.

In Pennsylvania one mine reported screening brown ore; at one mine the Grondal concentrating process was employed; one magnetite mine reported desulphurization by sintering; and at another mine the ore was roasted and sintered. The shipments of beneficiated ore from this State amounted to 410,425 gross tons, valued at $2,016,104, in 1919, compared with 273,874 tons, valued at $1,567,473 in 1918.

In Tennessee hematite from the mines of the Rockwood-Cardiff area was improved by breaking and hand picking, and brown ore from seven mines in the west-central belt was beneficiated. At three of these brown-ore mines washing was reported as the only method; the others reported hand picking, washing, and jigging. In all probability, however, hand picking is employed to a greater or less extent at nearly all brown-ore mines at which the ore occurs with gravel. Calcining of brown ore is practiced at one cold-blast furnace. The total beneficiated iron ore shipped from mines in Tennessee in 1919 was 170,831 gross tons, valued at $508,464, compared with 235,237 tons, valued at $692,999 in 1918.

Washing and calcining of brown ore was reported by one mine in Texas in 1919.

Four mines reported beneficiation of brown ore in Virginia in 1919, compared with three in 1918. At one mine hematite was improved by picking. The total shipments of treated ore in 1919 amounted to 132,005 gross tons, valued at $479,235, compared with 77,134 tons, valued at $245,967, in 1918. Washing, crushing, screening, and jigging were the methods employed in treating the brown ore.

The brown ores of the Mayari mines, Cuba, have been nodulized for many years at an extensive plant at Fenton on Nipe Bay. The total quantity of this ore reported as shipped in 1919 amounted to 78,080 gross tons, compared with 229,340 tons in 1918.

The total beneficiated ore reported as shipped from mines in the United States in 1919 decreased nearly 7 per cent in quantity and 8 per cent in value, as compared with 1918. From such figures as are available, showing the relation between crude ore treated and beneficiated ore recovered, it is apparent that in washing brown ore the ratios, by weight, of crude ore washed to resultant concentrates range from 6:1 to 1.077:1; in concentrating hematite the ratios range from 1.957:1 to 1.094:1; and in magnetite they range from 3.563:1 to 1.077:1.

Beneficiated iron ore shipped from mines in the United States, 1918 and 1919.

State.	Variety.	1918		1919	
		Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Alabama	Hematite, brown ore	986,630	$3,323,329	862,843	$2,821,857
Georgia	Brown ore	107,244	434,227	62,582	255,523
Michigan	Hematite	(a)	(a)	159,638	593,378
Minnesota	do	5,012,060	15,859,429	4,714,547	15,647,252
New Jersey	Magnetite, brown ore	370,373	1,935,920	336,629	1,712,255
New York	Magnetite	716,378	4,840,642	444,336	2,721,440
North Carolina	Brown ore, magnetite	45,492	248,709	39,830	154,331
Pennsylvania	do	273,874	1,567,473	410,425	2,016,104
Tennessee	Hematite, brown ore	235,237	692,999	170,831	508,464
Virginia	do	77,134	245,967	132,005	479,235
Other States [b]	Hematite, brown ore, magnetite.	57,148	249,180	22,268	114,802
		7,881,570	29,397,875	7,355,934	27,024,641

[a] Included with "Other States."
[b] 1918: Connecticut, Massachusetts, Michigan, and Missouri; 1919: Connecticut, Maryland, Massachusetts, New Mexico, and Texas.

IRON AND STEEL.

The records of the production and sales of iron and steel in 1919, in comparison with former years, are shown in the following pages. The data are derived in part from producers who report directly to the United States Geological Survey and in part from several other authoritative sources, such as the American Iron and Steel Institute, Metal Statistics, the Iron Age, the Iron Trade Review, and the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

PIG IRON.

SHIPMENTS, VALUE, AND PRODUCTION, BY STATES.

According to reports to the United States Geological Survey by the manufacturers, the shipments of pig iron, exclusive of ferroalloys, in 1919 decreased 21 per cent in quantity and 34 per cent in gross value as compared with 1918. The values represent the approximate amounts received for the iron f. o. b. at the furnaces and eliminate freight costs, selling commissions, and other items which are included in some of the market prices of pig iron as published in the trade journals.

The pig iron shipped includes the metal produced from foreign as well as from domestic ore. The pig iron derived from ore imported from Algeria, Canada, Cuba, Spain, and Sweden, although it constitutes a very small percentage of the total production, amounted in 1919 to 273,551 gross tons, valued at $8,105,532, as compared with 452,300 tons, valued at $15,923,400, in 1918. In the manufacture in 1919 of 307,611 gross tons of pig iron, 526,588 gross tons of foreign iron ore, including 5,803 tons of cinder derived from foreign pyrite, was reported to have been used, thus indicating an average pig-iron yield of 58.42 per cent from imported ore. Domestic ore, including 3,715,645 tons of cinder, scale, and scrap, and amounting to 58,666,268 gross tons, was reported in 1919 as used in the manufacture of 30,200,511 tons of pig iron, thus indicating a yield of 51.48 per cent in

pig iron from domestic materials. The total production in 1919 of pig iron, exclusive of ferroalloys, reported to the Geological Survey was 30,508,122 gross tons.

In the second following table are given the shipments and their value at the furnaces of pig iron by the principal grades in 1918 and 1919.

Pig iron shipped from blast furnaces in the United States in 1918 and 1919, by States.

State.	1918		1919		Decrease in 1919.		Percentage of decrease, 1919.	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity.	Value.
Alabama	2,645,179	$80,893,687	2,044,937	$53,092,133	600,242	$27,801,554	23	34
Illinois	3,409,876	105,415,030	2,532,341	61,829,286	877,535	43,585,744	26	41
Indiana	2,583,375	75,149,991	2,287,068	51,474,116	296,307	23,675,875	11	32
Kentucky	234,952	8,031,994	149,951	4,508,129	85,001	3,523,865	36	44
Michigan	502,884	17,823,684	416,277	13,418,185	86,607	4,405,499	17	25
Missouri	83,432	3,084,136	49,383	1,649,271	34,049	1,434,865	41	47
New Jersey	222,418	7,611,885	111,362	3,505,635	111,056	4,106,250	50	54
New York	2,482,450	70,167,542	1,854,594	49,784,659	627,856	20,382,883	25	29
Ohio	8,711,205	263,189,621	6,994,999	178,999,271	1,716,206	84,190,350	20	32
Pennsylvania	14,701,252	465,859,029	11,901,992	307,824,587	2,799,260	158,034,442	19	34
Tennessee	342,538	11,672,606	155,663	5,152,860	186,875	6,519,746	55	56
Virginia	453,863	15,430,473	288,458	9,094,135	165,405	6,336,338	36	41
West Virginia	(a)	(a)	250,310	6,267,067	(b)	(b)	(b)	(b)
Wisconsin	363,225	13,832,908	282,830	8,320,521	80,395	5,512,387	22	40
Other States[c]	1,493,791	42,596,979	810,066	20,995,188	b433,415	b15,334,724	b29	b36
	38,230,440	1,180,759,565	30,130,231	775,915,043	8,100,209	404,844,522	21	34

[a] Included with "Other States."
[b] Decrease in West Virginia included in "Other States."
[c] 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia; 1919: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Texas, and Washington.

Pig iron shipped from blast furnaces in the United States in 1918 and 1919, by grades.

Grade.	1918			1919		
	Quantity (gross tons).	Value.	Average price a ton.	Quantity (gross tons).	Value.	Average price a ton.
Charcoal	344,507	$13,392,324	$38.87	273,161	$9,919,171	$36.31
Foundry	5,295,262	176,959,909	33.42	4,470,429	132,024,290	29.53
Basic	18,621,883	544,770,305	29.25	14,512,958	348,886,821	24.04
Bessemer	11,751,540	360,901,939	30.71	9,267,342	233,860,019	25.23
Low phosphorus	598,927	31,459,638	52.53	284,891	12,383,465	43.47
Malleable	1,182,727	39,268,446	33.20	969,406	29,258,377	30.18
Forge	366,356	11,668,069	31.85	282,799	7,741,897	27.38
All other (not ferroalloys)	69,238	2,338,935	33.78	69,245	1,841,003	26.59
	38,230,440	1,180,759,565	30.89	30,130,231	775,915,043	25.75

The bureau of statistics of the American Iron and Steel Institute reports that the production in 1919 of all kinds of pig iron, including ferroalloys, produced in blast furnaces as well as some that were electrically produced, decreased 8,039,280 tons, or nearly 21 per cent, as compared with 1918.

Pig iron, including ferroalloys, manufactured in the United States in 1918 and 1919, in gross tons.[a]

State.	1918	1919	State.	1918	1919
Pennsylvania	15,198,271	12,276,585	Missouri	504,463	375,587
Ohio	8,764,132	7,102,627	Iowa		
Illinois	3,440,307	2,558,213	Colorado		
Alabama	2,587,852	2,130,092	Montana		
Indiana	3,073,599	2,715,659	Washington		
Michigan			Oregon		
New York	2,871,118	2,070,288	California		
New Jersey			Maryland	373,817	244,002
Wisconsin	750,366	605,619	Tennessee	369,822	190,514
Minnesota			Connecticut	12,485	13,678
West Virginia	594,675	413,091	Massachusetts		
Georgia			Maine		
Kentucky					
Texas				39,054,644	31,015,364
Virginia	513,737	319,409			

[a] Bureau of statistics of the American Iron and Steel Institute.

AVERAGE PRICES.

The average price per gross ton of all kinds of pig iron, by States, from 1914 to 1919, given in the following table is based on reports of the manufacturers to the Survey. These figures represent the approximate prices f. o. b. at the blast furnaces and do not include the prices of ferroalloys.

The general average price for all grades of pig iron at the furnaces, exclusive of ferroalloys, for the year 1919 was $25.75, as compared with $30.89 in 1918, a decrease of nearly 17 per cent.

Average price per gross ton of pig iron at blast furnaces in the United States, 1914–1919.

State.	1914	1915	1916	1917	1918	1919
Alabama	$10.52	$10.24	$14.59	$21.64	$30.58	$25.96
Illinois	13.59	13.93	17.57	26.34	30.91	24.42
Indiana	(a)	(a)	(a)	(a)	29.09	22.51
Kentucky	12.24	13.44	17.97	28.78	34.19	30.06
Michigan	13.78	13.63	17.51	29.93	35.44	32.23
Missouri	(a)	(a)	(a)	(a)	36.97	33.40
New Jersey	(a)	(a)	(a)	35.25	34.22	31.48
New York	14.26	14.02	17.70	22.98	28.27	26.84
Ohio	13.46	12.96	15.75	27.30	30.31	25.59
Pennsylvania	13.78	13.69	17.95	29.87	31.69	25.86
Tennessee	12.05	12.09	15.13	26.26	34.08	33.10
Virginia	12.53	12.83	16.06	27.93	34.00	31.53
West Virginia	(a)	(a)	(a)	(a)	(a)	25.04
Wisconsin	13.35	13.20	17.77	27.39	38.08	29.42
Other States [b]	13.55	12.96	16.03	24.25	28.52	25.92
Average for United States	13.42	13.21	16.96	27.29	30.89	25.75

[a] Included in "Other States."

[b] 1914: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Mississippi, Missouri, New Jersey, and West Virginia; 1915: Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1916: California, Colorado, Connecticut, Indiana, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, and West Virginia; 1917: Colorado, Connecticut, Georgia, Indiana, Maryland, Massachusetts, Minnesota, Missouri, Washington, and West Virginia; 1918: Colorado, Connecticut, Georgia, Maryland, Massachusetts, Minnesota, Washington, and West Virginia; 1919: Colorado, Connecticut, Maryland, Massachusetts, Minnesota, Texas, and Washington.

In the following summary of the annual average price per gross ton of pig iron in the United States for 1889 to 1919 the prices prior to 1907 include the cost of transportation of some pig iron from blast furnaces to markets. Prior to 1910 the values of blast-furnace ferroalloys are included. Since 1910 the prices represent, as closely as can be ascertained, the average price paid for pig iron at the blast furnaces. The extreme range in prices is from $9.76 in 1894 to $30.89 in 1918. The lowest prices were in the years 1894 to 1898, and the highest in 1902 to 1907 and 1917 to 1919.

Average price per gross ton of pig iron in the United States, 1889–1919.

1889	$15.78	1900	$18.85	1910	$15.45
1890	16.43	1901	15.25	1911	14.07
1891	15.50	1902	20.92	1912	13.93
1892	14.32	1903	19.12	1913	15.08
1893	11.90	1904	14.13	1914	13.42
1894	9.76	1905	16.63	1915	13.21
1895	11.14	1906	19.98	1916	16.96
1896	10.47	1907	20.56	1917	27.29
1897	9.85	1908	15.96	1918	30.89
1898	9.90	1909	16.25	1919	25.75
1899	18.00				

Average quoted monthly prices per ton of principal grades of pig iron, 1918 and 1919.[a]

Month.	1918				1919			
	Foundry pig iron at Valley furnaces.	Foundry pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.	Foundry pig iron at Valley furnaces.	Foundry pig iron at Birmingham, Ala., furnaces.	Bessemer pig iron at Valley furnaces.	Basic pig iron at Valley furnaces.
January	$33.00	$33.00	$36.30	$33.00	$31.00	$31.00	$32.20	$30.00
February	33.00	33.00	36.30	33.00	31.00	31.00	32.20	30.00
March	33.00	33.00	36.13	32.85	27.88	28.44	30.73	28.53
April	33.00	33.00	35.20	32.00	26.75	26.75	27.95	25.75
May	33.00	33.00	35.20	32.00	26.75	25.28	27.95	25.75
June	33.00	33.00	35.20	32.00	26.75	24.14	27.95	25.09
July	33.00	33.00	35.20	32.00	26.75	25.01	27.95	25.75
August	33.00	33.00	35.20	32.00	26.75	27.18	27.95	25.75
September	33.20	33.20	35.20	32.20	26.75	27.50	27.95	25.75
October	34.00	34.00	35.20	33.00	26.90	27.78	27.95	25.75
November	34.00	34.00	35.20	33.00	30.76	30.21	29.44	27.83
December	34.00	33.16	35.20	33.00	35.46	34.81	35.27	33.88
Average	33.27	33.20	35.46	32.50	28.63	28.34	29.62	27.49

[a] Metal Statistics, 1920.

BLAST FURNACES.

The number of furnaces in blast on June 30 and December 31 and the total number of stacks recorded for the years 1918 and 1919, not including any electric reduction furnaces, as published by the bureau of statistics of the American Iron and Steel Institute, are as follows:

Blast furnaces in the United States, 1918 and 1919.

State.	Furnaces in blast June 30, 1918.	Dec. 31, 1918.			Furnaces in blast June 30, 1919.	Dec. 31, 1919.		
		In.	Out.	Total.		In.	Out.	Total.
Pennsylvania	137	127	38	165	75	112	53	165
Ohio	71	74	5	79	48	54	25	79
Illinois	24	23	2	25	12	19	6	25
Alabama	31	30	14	44	17	22	22	44
New York	24	23	4	27	15	16	11	27
Virginia	13	13	6	19	3	6	12	18
Tennessee	12	9	7	16	2	7	9	16
Colorado	4	3	3	6	3	0	6	6
Missouri	2	3	0	3	2	2	1	3
Oregon	0	0	1	1	0	0	1	1
Washington	1	1	0	1	0	0	0	0
Maryland	4	3	2	5	1	4	1	5
New Jersey	4	3	2	5	2	1	3	4
Wisconsin	4	5	3	8	2	4	4	8
Minnesota	3	3	0	3	2	3	0	3
Indiana	15	16	0	16	11	13	3	16
Michigan	11	12	2	14	12	10	2	12
West Virginia	3	4	0	4	1	2	3	5
Kentucky	5	5	2	7	1	4	3	7
Georgia	0	0	4	4	0	0	4	4
Texas	0	0	2	2	0	0	1	1
Mississippi	0	0	1	1	0	0	1	1
Connecticut	2	2	0	2	0	0	2	2
Massachusetts	1	1	1	2	0	1	0	1
	371	360	99	459	209	280	173	453

PRODUCTION OF PIG IRON, BY GRADES.

The statistics of production of the principal grades of pig iron for 1915 to 1919 have been published by the American Iron and Steel Institute as follows:

Pig iron manufactured in the United States, 1915–1919, by grades, in gross tons.

Grade.	1915	1916	1917	1918	1919
Bessemer and low phosphorus	10,523,306	14,422,457	13,714,732	13,024,966	9,975,934
Basic (mineral fuel)	[a]13,093,214	17,684,087	17,671,662	18,646,174	14,494,131
Forge pig iron	316,214	348,344	345,707	393,932	271,286
Foundry and ferrosilicon	4,843,899	5,553,644	5,328,258	5,145,260	4,916,758
Malleable	829,921	921,486	1,015,579	1,117,914	1,009,049
Spiegeleisen	97,885	194,002	192,985	283,853	84,246
Ferromanganese	149,521	221,532	260,125	333,027	185,357
White, mottled, direct castings, etc	62,253	89,245	92,168	109,518	78,603
	29,916,213	39,434,797	38,621,216	39,054,644	31,015,364

[a] Includes a small quantity of basic iron made with charcoal.

PRODUCTION OF PIG IRON, ACCORDING TO FUEL USED.

In the following table are given the statistics of the American Iron and Steel Institute showing the production of pig iron, including ferroalloys, according to the fuel used, from 1915 to 1919. Metal made with electricity, and coke and electricity, is included in coke pig iron. The charcoal figures for 1915 also include small quantities of ferroalloys made with charcoal and electricity.

Pig iron manufactured in the United States, 1915–1919, by fuel used, in gross tons.

Fuel used.	1915	1916	1917	1918	1919
Bituminous, chiefly coke	29,535,308	38,844,598	37,863,643	38,422,175	30,549,930
Anthracite and coke	84,753	217,788	381,048	283,592	138,337
Charcoal	296,152	372,411	376,525	348,877	327,097
	29,916,213	39,434,797	38,621,216	39,054,644	31,015,364

TOTAL DOMESTIC PRODUCTION OF PIG IRON.

The next table shows the production in the United States of pig iron, including the commoner ferroalloys, as far as has been recorded.

Pig iron manufactured in the United States, 1810–1919, in gross tons.

Year.	Quantity.	Year.	Quantity.	Year.	Quantity.
1810–1860	10,542,548	1911	23,649,547	1917	38,621,216
1861–1870	11,366,963	1912	29,726,937	1918	39,054,644
1871–1880	24,055,278	1913	30,966,152	1919	31,015,364
1881–1890	56,902,041	1914	23,332,244		
1891–1900	98,124,754	1915	29,916,213		698,030,632
1901–1910	211,321,934	1916	39,434,797		

FOREIGN TRADE IN PIG IRON.

IMPORTS.

The quantity of pig iron and ferroalloys, the principal of which were ferromanganese and ferrosilicon, imported into the United States in 1919, increased 193 per cent, compared with 1918. This increase does not, however, represent a large quantity. Separate statistics of imports of ferroalloys given on page 648 indicate that the imports of pig iron alone (by difference) were 58,171 gross tons in 1919, compared with 34 tons in 1918. England and Canada furnished the largest quantity of these products in both years. The large increase in imports from Canada and Mexico is noteworthy.

Pig iron, including kentledge, ferromanganese, ferrosilicon, and spiegeleisen, imported into the United States, 1915–1919, in gross tons.

Country.	1915	1916	1917	1918	1919
North America:					
Canada	21,166	33,716	21,143	5,692	63,091
Mexico	.....	.....	.....	120	5,994
West Indies	.....	.....	83	.....	30
Europe:					
France	20	.....	.....	.....	.....
Germany	600	341	.....	.....	.....
Italy	.....	.....	20	.....	.....
Sweden	1,392	792	.....	.....	51
United Kingdom: England	59,105	89,764	51,384	28,392	32,452
United Kingdom: Scotland	792	.....	250	.....	39
Asia:					
British India	2,382	1,313	.....	501	.....
China	3,430	8,861	3,503	.....	8
Japan	250	562	85	6	.....
Other countries	699	.....	318	.....	.....
	89,836	135,349	76,786	34,711	101,665

EXPORTS.

The pig iron exported from the United States in 1919 increased 19 per cent in quantity and 6 per cent in value, compared with 1918. The largest quantity was shipped in 1919 to Italy, and considerable quantities were shipped also to Japan, England, and Canada. As is indicated in the table, trade was resumed with several European countries that imported no pig iron from the United States in 1918.

Pig iron exported from the United States to foreign countries, 1915–1919, in gross tons.

Country.	1915	1916	1917	1918	1919
North America:					
Canada	60,197	101,277	153,745	122,325	33,751
Costa Rica	50	68	26	.....	.....
Mexico	684	676	920	297	1,103
Panama	2,316	1,968	1,816	881	483
Cuba	844	5,338	4,243	892	1,331
South America:					
Argentina	912	380	2,580	129	4,137
Brazil	304	1,176	1,483	72	979
Chile	2,716	6,500	8,888	4,345	6,611
Peru	286	682	578	694	1,253
Europe:					
Austria-Hungary	.....	.....	.....	.....	417
Belgium	.....	.....	.....	.....	8,625
Denmark	.....	17,380	1,836	.....	5,776
France	9,414	71,226	65,618	8,181	683
Greece	.....	50	.....	.....	40
Italy	81,792	234,213	184,763	41,641	136,997
Netherlands	1,993	22,464	2,124	.....	5,220
Norway	.....	11,267	12,986	1,000	2,995
Russia	.....	926	6,017	.....	.....
Spain	.....	8,464	5,891	.....	.....
Sweden	.....	20,707	17,799	.....	2,844
Switzerland	.....	3,671	1,404	.....	.....
United Kingdom:					
England	57,368	88,315	138,196	66,197	34,741
Scotland	.....	2,249	7,874	7,591	11,268
Ireland	.....	357	1,610	313	.....
Asia:					
Japan	1,811	5,033	30,809	11,986	49,734
Oceania:					
Australia	2,008	433	257	30	259
New Zealand	.....	260	760	.....	716
All other countries	1,814	2,156	3,997	3,001	11,298
	224,509	607,236	656,220	269,575	321,261
Value	$3,667,167	$15,381,431	$24,037,051	$11,576,721	$12,313,183

FERROALLOYS.

SHIPMENTS AND VALUE.

The output of ferroalloys in the United States is separated from that of pig iron in these compilations primarily in order to arrive at more nearly accurate values for these commodities. For instance, the quantity of ferroalloys of all classes (which the Survey is at liberty to publish) reported as shipped or used amounted to only about 1.3 per cent of the total shipments of pig iron in 1919, but the price per ton was so much greater as to have an important influence on the apparent average price of the pig iron and, had it been included with the pig iron, would have made the average price $26.94 instead of $25.75 a ton. The quantity reported falls short of the actual production in the United States, as the figures of output of certain electrically produced ferroalloys are not available for publication by the Geological Survey.

There is a sufficient number of producers of the commoner ferroalloys, such as ferromanganese, spiegeleisen, ferrotungsten, and ferrosilicon, to enable the Survey to publish the reported production of these four types of alloys separately; but the production of the rarer alloys, among which are ferrocerium, ferrochromium, ferromolybdenum, ferrotitanium, ferrozirconium, ferrovanadium, and ferrouranium, must be grouped together.

The shipments of ferroalloys of all classes in 1919, as reported to the United States Geological Survey, decreased 48 per cent in quantity and 60 per cent in value, as compared with 1918. Of the shipments in 1919, it is calculated that 136,671 gross tons, valued at $24,028,150, were made from imported ores derived from Africa, Brazil, British Columbia, Chile, China, Costa Rica, Cuba, Guatemala, India, Japan, Mexico, Panama, Peru, Porto Rico, Portugal, and Turkey. The ferrovanadium, ferromolybdenum, ferromanganese, spiegeleisen, ferrotungsten, ferrochromium, and ferrotitanium were made in part or wholly from imported ore.

The reported shipments of ferromanganese in 1919 were valued at an average of $136.66 a ton and compared with 1918 decreased in quantity 35 per cent and in total value 61 per cent. The reported shipments of spiegeleisen in 1919 were valued at $43.65 a ton and decreased in quantity 66 per cent and in total value 77 per cent. The reported sales of ferrosilicon in 1919 were valued at $50.26 a ton. The shipments of ferrophosphorus in 1919 were valued at $106.52 a ton. The sales of alloys of iron with the rarer metals—chromium, molybdenum, tungsten, titanium, zirconium, and vanadium—as reported to the Survey were valued at an average of $1,437 a ton in 1919, compared with $1,880 a ton in 1918. Ferrotungsten shipments in 1919 were valued at an average of $2,968 a ton.

The following tables give an incomplete outline of the shipments of ferroalloys in the United States in 1917, 1918, and 1919:

Ferroalloys of domestic manufacture shipped, 1917–1919.

Variety of alloy.	1917		1918		1919	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Ferromanganese	260,225	$53,930,771	306,076	$69,045,678	198,255	$27,093,816
Spiegeleisen	189,241	9,756,236	263,861	17,276,494	90,855	3,965,754
Ferrosilicon	175,079	8,562,182	171,756	11,864,904	89,102	4,478,261
Ferrophosphorus					6,706	714,339
Ferrotungsten (50 per cent or more of tungsten)	1,258	4,225,070	2,142	7,798,898	917	2,721,852
Other varieties[a]	8,218	7,257,465	7,033	9,447,969	6,066	7,316,123
	634,021	83,731,724	750,868	115,433,943	391,901	46,290,145

[a] 1917: Ferrocerium, ferrochromium, ferromolybdenum, ferrocarbontitanium, ferrouranium, and ferrovanadium; 1918: Ferrocarbontitanium, ferrocerium, ferrochromium, ferromolybdenum, ferrotitanium, ferrouranium, ferrovanadium, and ferrozirconium; 1919: Ferrochromium, ferromolybdenum, ferrotitanium, ferrovanadium, and ferrozirconium.

Ferroalloys of domestic manufacture shipped in 1913–1919, in gross tons.

Year.	Ferro-manganese.	Spiegel-eisen.	Other varieties.	Total quantity.	Total value.
1913	119,495	106,980	69,732	296,207	$13,015,362
1914	100,731	76,625	78,168	255,524	9,350,245
1915	144,260	114,556	129,828	388,644	17,450,385
1916	224,103	182,837	182,798	589,738	50,281,692
1917	260,225	189,241	184,555	634,021	83,731,724
1918	306,076	263,861	180,931	750,868	115,433,943
1919	198,255	90,855	102,791	391,901	46,290,145

In 1919 ferromanganese was reported to have been made at 19 localities in the United States, spiegeleisen at 11, ferrosilicon at 19, ferrophosphorus at 3, ferrochromium at 8, ferromolybdenum at 4, ferrotitanium at 1, ferrotungsten at 8, ferrozirconium at 1, and ferrovanadium at 5.

The following table shows the number of localities at which the principal ferroalloys were manufactured in 1917, 1918, and 1919, but these operations do not include all those at which ferroalloys were manufactured electrically. In many places, of course, several alloys were made at the same plant. In all there were reported 48 localities at which ferroalloys were made in 1919, compared with 61 in 1918.

Number of places, by States, at which ferroalloys were manufactured in 1917, 1918, and 1919.

State and alloy.	1917	1918	1919
Alabama:			
Ferromanganese	3	3	2
Spiegeleisen	3	3	2
Ferrosilicon	.....	.....	1
Ferrochromium	.....	.....	1
Ferrophosphorus	.....	.....	1
California:			
Ferromanganese	1	2	1
Ferrosilicon	1	1	.....
Ferrochromium	1	.....	1
Ferromolybdenum	1	.....	1
Ferrotungsten	1	.....	.....
Colorado:			
Ferromanganese	.....	.....	1
Spiegeleisen	1	1	.....
Ferrosilicon	1	1	.....
Ferrochromium	1	1	1
Ferromolybdenum	1	.....	.....
Ferrotungsten	2	2	1
Ferrovanadium	.....	.....	1
District of Columbia:			
Ferrotungsten	.....	.....	1
Ferromolybdenum	.....	.....	1
Illinois:			
Ferromanganese	2	1	1
Spiegeleisen	2	1	1
Ferrosilicon	.....	.....	1
Iowa:			
Ferrosilicon	1	1	1
Ferrochromium	.....	.....	1
Ferrophosphorus	.....	.....	1
Kentucky:			
Ferrosilicon	1	.....	.....
Maryland:			
Ferromanganese	1	.....	.....
Ferrochromium	.....	1	1
Ferrosilicon	1	1	1
Ferrotungsten	1	1	.....
Montana:			
Ferromanganese	.....	1	.....
New Jersey:			
Ferromanganese	1	1	.....
Ferrochromium	.....	1	1
Ferrotungsten	.....	1	1
Ferrotitanium	.....	1	.....
Ferrozirconium	.....	1	1
Ferrovanadium	.....	1	1
New York:			
Ferromanganese	1	2	1
Ferrosilicon	5	8	5
Ferrochromium	.....	.....	1
Ferrotitanium	1	1	1
Ferrotungsten	1	1	1
Ohio:			
Ferrosilicon	4	4	5
Oregon:			
Ferromanganese	1	1	.....
Pennsylvania:			
Ferromanganese	9	12	10
Spiegeleisen	9	11	7
Ferrosilicon	1	1	2
Ferrocerium	1	1	.....
Ferrochromium	1	1	1
Ferromolybdenum	1	2	2
Ferrotungsten	3	3	4
Ferrouranium	1	1	.....
Ferrovanadium	4	5	3
Tennessee:			
Ferrosilicon	2	3	2
Ferrophosphorus	1	1	1
Virginia:			
Ferromanganese	2	3	2
Spiegeleisen	3	3	1
Washington:			
Ferromanganese	2	2	1
Ferrochromium	1	.....	.....
Ferrosilicon	.....	.....	1

The following records of average contract prices of ferromanganese at eastern seaboard and of spiegeleisen at furnaces by months for the last four years are of interest.

Quoted prices per ton of ferromanganese and spiegeleisen, 1916, 1917, 1918, and 1919.[a]

Month.	Ferromanganese.				Spiegeleisen.			
	1916	1917	1918	1919	1916	1917	1918	1919
January	$110.00	$175.00	$250.00	[b] $212.50	$32.50	$57.50	$59.00	[c] $67.50
February	140.00	192.50	250.00	165.00	42.50	66.25	59.00	[c] 52.50
March	175.00	212.50	250.00	134.00	55.00	77.50	65.50	[c] 42.50
April	175.00	250.00	250.00	113.75	60.00	76.75	[c] 70.00	[c] 34.50
May	175.00	375.00	[b] 250.00	110.00	60.00	78.00	[c] 71.00	[c] 31.35
June	175.00	400.00	[b] 250.00	111.75	55.00	83.00	[c] 75.00	[c] 27.50
July	175.00	400.00	[b] 250.00	111.00	47.50	85.00	[c] 75.00	34.00
August	170.00	387.50	[b] 250.00	110.00	47.50	81.25	[c] 75.00	34.00
September	164.00	380.00	[b] 250.00	105.00	45.00	80.50	[c] 75.00	34.00
October	160.00	300.00	[b] 250.00	110.00	40.00	73.50	[c] 75.00	34.00
November	155.00	247.50	[b] 250.00	110.00	45.00	63.25	[c] 75.00	34.00
December	162.50	247.50	[b] 236.00	121.00	50.00	60.00	[c] 72.50	39.00

[a] Iron Trade Review.
[b] Prices from May, 1918, to January, 1919, inclusive, based on 70 per cent ferromanganese; all other prices based on 80 per cent.
[c] Prices from April, 1918, to June, 1919, inclusive, based on 16 per cent spiegeleisen; all other prices based on 20 per cent.

IMPORTS.

The imports for consumption of all classes of ferroalloys into the United States in 1919, according to the reports of the Bureau of Foreign and Domestic Commerce, are given in the following table. The imports of ferromanganese were valued at $129.72 a ton, as compared with $156.76 in 1918. The imports of spiegeleisen were valued at $37.70 a ton, as compared with $115.80 in 1918. The values declared on the imports for 1918 do not correspond very closely with the averages or ranges in market value, ferromanganese being low and spiegeleisen high. The imports of the alloys of the rarer metals are not all reported separately. For instance, the imports of ferrochromium, ferromolybdenum, and ferrotungsten are included with those of their respective metals. For the sake of comparison, however, such statistics as are available are presented in the following two tables:

Ferroalloys imported for consumption in the United States, 1917–1919.

Variety of alloy.	1917		1918		1919	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Chrome or chromium and ferrochromium					414	$100,404
Ferrophosphorus	85	$5,458	10	$1,055	176	13,388
Ferrosilicon	9,740	691,684	5,540	424,932	10,445	629,362
Molybdenum and ferromolybdenum			32	19,280	46	40,759
Titanium and ferrotitanium			(a)	10	5	3,317
Tungsten and ferrotungsten	1	3,606		8	177	287,981
Ferromanganese	41,969	5,710,988	27,168	4,258,745	33,022	4,283,541
Ferrovanadium					5	24,923
Spiegeleisen	3,968	291,594	1,969	228,012	27	1,018
	55,763	6,703,330	34,719	4,932,042	44,317	5,384,693

[a] 10 pounds.

Ferromanganese and ferrosilicon imported into the United States in 1917, 1918, and 1919, by countries.

[General imports.]

Country.	Alloy.	1917		1918		1919	
		Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Canada	Ferromanganese					551	$59,146
	Ferrosilicon	9,729	$689,902			10,445	629,362
England	Ferromanganese	45,059	6,054,188	27,162	$4,257,501	32,402	4,215,939
Scotland	Ferromanganese	250	38,932			39	6,484
Japan	Ferromanganese	72	14,259	6	1,244		
	Ferrosilicon	11	1,782	5,540	424,932		
Cuba	Ferromanganese					30	1,972

STEEL.

PRODUCTION OF STEEL, BY STATES AND KINDS.

The following tables showing the production of steel were compiled by the bureau of statistics of the American Iron and Steel Institute. No data whatever are available on the value of the output of crude steel at the mills, but the weekly issues and annual statistical reviews of the Iron Age give market quotations of prices of steel billets and of some of the leading forms of finished steel. The price of Bessemer steel billets at Pittsburgh during 1919 ranged between $38.50 and $46 a gross ton, but while under Government control the price was stationary at $47.50 during 1918. Tank plates ranged from 2.53 to 3 cents a pound in 1919; the Government price in 1918 was 3.25 cents a pound, except in December, when it was 3.13 cents a pound. Steel beams at Pittsburgh ranged from 2.45 to 2.80 cents a pound in 1919 and were priced by the Government at 3 cents during 1918, except in December, when they cost 2.90 cents a pound.

Bessemer steel ingots and castings manufactured in the United States, 1915–1919, in gross tons.

State.	1915	1916	1917	1918	1919
Ohio	3,929,665	4,711,784	4,256,337	3,920,442	3,073,941
Pennsylvania	2,507,243	3,444,163	3,537,094	3,281,941	2,851,402
Illinois	1,270,502	1,958,259	1,763,052	1,229,568	906,324
Other States	579,803	944,833	923,477	944,285	439,895
	8,287,213	11,059,039	10,479,960	9,376,236	7,271,562

Open-hearth steel ingots and castings manufactured in the United States, 1915–1919, in gross tons.

State.	1915	1916	1917	1918	1919
New England States	191,582	278,768	332,597	329,630	286,826
New York and New Jersey	1,266,017	1,872,258	2,110,846	2,245,239	1,296,005
Pennsylvania	13,245,393	16,030,251	16,284,102	15,574,101	12,692,112
Ohio	3,521,404	5,057,751	6,074,857	6,729,955	5,112,616
Indiana	2,504,427	3,243,961	3,722,931	3,910,899	3,122,486
Illinois	1,169,657	1,812,169	1,966,296	2,283,991	1,664,993
Other States	1,780,622	3,120,269	3,657,264	3,385,576	2,773,656
	23,679,102	31,415,427	34,148,893	34,459,391	26,948,694

According to these tables there was a decrease of more than 22 per cent in the production of Bessemer steel and of open-hearth steel in 1919 compared with that of 1918. The total production of steel in 1919 therefore decreased 22 per cent compared with 1918. Of the total output in 1919, nearly 78 per cent was represented by open-hearth steel, nearly 21 per cent by Bessemer steel, and more than 1 per cent by all other classes of steel.

Of the total output in 1919 of open-hearth steel, 25,719,312 gross tons was made by the basic process and 1,229,382 tons by the acid process.

PRODUCTION OF STEEL IN ELECTRIC FURNACE.

The production of steel by the electric process in 1919 amounted to 384,452 gross tons, a decrease of 25 per cent as compared with 1918. The following table gives the production of electric steel ingots and castings since 1909. In 1908 there were 55 tons of electric steel produced, but this quantity was included with open-hearth steel for that year.

Steel electrically manufactured in the United States, 1909 to 1919, in gross tons.

Year.	Ingots.	Castings.	Total.	Year.	Ingots.	Castings.	Total.
1909	13,456	306	13,762	1915	46,348	23,064	69,412
1910	50,821	1,320	52,141	1916	126,048	42,870	168,918
1911	27,227	1,878	29,105	1917	239,632	64,911	304,543
1912	14,147	4,162	18,309	1918	403,068	108,296	511,364
1913	20,973	9,207	30,180	1919	272,942	111,510	384,452
1914	15,458	8,551	24,009				

In the total production of electric steel in 1919 are included 179,166 tons of steel ingots and castings which were treated with ferrovanadium, ferrotitanium, ferrochromium, or other alloys, of which 175,575 tons were ingots and 3,591 were castings, compared with 290,961 tons—287,885 tons of ingots and 3,076 tons of castings—so treated in 1918.

On December 31, 1919, the number of completed plants equipped for the manufacture of steel by the electric process was 165, as compared with 128 plants at the end of 1918, a gain of 37 plants. On January 1, 1919, it was reported that there were 287 electric furnaces of all types in the United States and 40 in Canada, and at the end of the year these totals had increased to 323 in the United States and 43 in Canada. The total number of furnaces in the world at the beginning and end of 1919 was estimated at 815 and about 875, respectively, as compared with 140 in 1913.[5]

[5] Cone, E. F., The status of the electric steel industry: Iron Age, Jan. 1, 1920, pp. 75–77.

TOTAL DOMESTIC PRODUCTION OF STEEL.

Steel produced in the United States, 1810–1919, in gross tons.

Year.	Bessemer.	Open-hearth.	Crucible.	Other steel.	Total.
1810–1870	58,482	2,232	146,370		207,084
1871	40,179	1,785	31,250		73,214
1872–1880	4,293,896	245,035	349,730	76,009	4,964,670
1881–1890	21,596,699	2,387,925	703,489	37,044	24,725,157
1891–1900	49,387,341	15,392,764	762,446	35,820	65,578,371
1901–1910	94,048,698	92,418,814	1,051,379	154,683	187,673,574
1911	7,947,854	15,598,650	97,653	31,949	23,676,106
1912	10,327,901	20,780,723	121,517	21,162	31,251,303
1913	9,545,706	21,599,931	121,226	34,011	31,300,874
1914	6,220,846	17,174,684	89,869	27,631	23,513,030
1915	8,287,213	23,679,102	113,782	70,939	32,151,036
1916	11,059,039	31,415,427	129,692	169,522	42,773,680
1917	10,479,960	34,148,893	126,716	305,038	45,060,607
1918	9,376,236	34,459,391	115,112	511,693	44,462,432
1919	7,271,562	26,948,694	63,572	387,404	34,671,232

FOREIGN TRADE IN STEEL.

The export trade in steel in the United States is indicated in the subjoined table of exports. For comparison the imports are tabulated also.

In 1917 the quantity of iron and steel exported (so far as recorded) increased 5 per cent, but in 1918 and 1919 the quantity decreased 12 and 20 per cent, respectively. The total value increased 57 per cent in 1917, but decreased 1 and 24 per cent, respectively, in 1918 and 1919. The stringency in shipping facilities and the war needs of the United States in 1917 and 1918 are responsible for the nearly stationary condition of the export trade in those years.

The outstanding decrease in 1919 was recorded by billets, ingots, and blooms, the decrease amounting to more than 1,500,000 tons.

Iron and steel imported into the United States, 1917–1919.

Article.	1917		1918		1919	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Scrap iron and steel	180,034	$2,437,423	63,730	$1,221,752	177,293	$3,249,322
Bar iron	2,240	193,831	1,469	194,597	1,940	220,863
Steel ingots, blooms, blanks, and billets	35,861	1,635,323	33,612	1,550,175	8,230	440,470
Steel bars, mill shafting, castings, etc.	8,337	2,313,613	[a] 1,415	[a] 167,050	5,271	612,350
Steel ingots, blooms, slabs, etc., made by crucible, electric, or cementation process			[b] 4,192	[b] 872,429		
			[a] 1,856	[a] 1,110,503	2,768	2,795,925
Rails for railway	9,263	307,139	8,705	341,985	17,008	651,830
Sheets and plates	1,747	526,788	1,517	632,558	1,096	455,559
Tin and terne plates	124	31,453	32	5,964	242	66,944
Wire rods	1,060	221,184	7,677	621,936	341	63,572
	238,666	7,666,754	124,205	6,718,949	214,189	8,556,835
Wire and articles made from wire		348,876		273,705		463,054
All other manufactures—free		82,993		551,304		564,174
All other manufactures—dutiable		4,072,935		4,807,597		3,834,741
		4,504,804		5,632,606		4,861,969
Grand total		12,171,558		12,351,555		13,418,804

[a] 6 months, July to December, 1918.
[b] 6 months, January to June, 1918.

Iron and steel exported from the United States, 1917–1919.

Article.	1917		1918		1919	
	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.	Quantity (gross tons).	Value.
Scrap and old, fit only for manufacture	145,574	$3,362,562	2,160	$63,626	27,275	$717,325
Bar iron	56,332	5,046,727	63,367	6,576,362	60,547	5,634,398
Bars or rods (of steel), wire rods	181,941	15,356,275	148,524	12,409,715	118,010	8,374,716
All other	626,465	59,703,761	579,250	64,575,140	554,212	48,297,598
Billets, ingots, and blooms, not elsewhere specified	2,017,113	161,391,007	1,786,189	150,568,151	258,424	19,370,787
Bolts and nuts	32,261	5,259,622	28,333	5,687,998	39,743	7,769,893
Hoops and bands	58,769	7,330,301	50,673	7,711,195	50,836	6,875,586
Horseshoes	8,403	1,594,952	2,857	424,208	3,385	539,452
Cut nails	4,525	434,736	3,823	440,281	2,921	393,284
Railroad spikes	21,188	2,069,808	4,649	600,174	24,771	2,896,073
Wire nails	114,912	12,088,147	78,726	9,921,123	89,779	10,744,696
All other (including tacks)	19,351	3,867,605	11,792	3,336,570	16,234	4,638,093
Cast-iron pipes and fittings	77,528	7,483,216	55,961	6,665,597	39,455	5,177,752
Wrought-iron pipes and fittings	127,191	16,659,553	89,982	14,993,957	236,080	35,229,750
Radiators and cast-iron house-heating boilers	5,201	672,331	2,857	548,800	4,656	779,259
Rails for railways, of steel	512,669	24,023,090	453,537	26,402,864	652,443	38,986,855
Galvanized iron and steel pipes	86,487	13,207,827	68,742	12,609,628	101,637	15,223,289
Iron sheets and plates, all other	62,238	7,540,780	40,756	6,315,095	39,892	4,837,547
Steel plates	525,660	65,888,695	551,967	64,678,628	710,013	56,701,651
Steel sheets	157,354	18,654,553	150,028	25,646,749	177,466	21,214,529
Structural iron and steel	294,150	24,437,289	232,792	21,468,452	360,787	28,956,816
Tin and terne plates	232,797	41,888,418	258,538	55,850,294	204,521	36,997,634
Barbed wire	193,471	19,775,784	235,083	23,492,540	101,451	11,534,297
All other wire	201,472	22,541,224	157,222	20,704,503	190,212	24,641,881
	5,763,052	540,218,263	5,057,808	541,751,650	4,064,750	396,533,161
Axes		1,023,184		1,006,848		1,613,862
Hammers and hatchets		568,892		484,670		973,547
Railway-track material, switches, frogs, fishplates, splices, bars, etc		8,194,270		5,546,969		9,280,725
Saws		5,113,514		3,790,416		4,851,791
Shovels and spades		509,559		686,591		1,398,101
All other tools		14,096,939		9,140,700		14,382,767
		29,506,358		20,650,194		52,500,793
Grand total		569,724,621		562,401,844		429,033,954

ZINC.

(GENERAL REPORT.)

By C. E. Siebenthal and A. Stoll.

SUMMARY.

Zinc produced and consumed in the United States, 1918–19, in short tons.

	1918	1919
Production of primary zinc: [a]		
From domestic ore	492,405	452,272
From foreign ore	25,522	13,471
	517,927	465,743
Production of secondary zinc: [a]		
Redistilled	9,918	19,748
Remelted	17,190	20,162
	545,035	505,653
Apparent consumption of primary zinc	423,792	323,964

[a] "Primary zinc," which is produced directly from ore, is here distinguished from "secondary zinc," which is obtained by refining zinc ashes, skimmings, drosses, and old metals. The statistics of secondary zinc are given on page 656. Wherever in this report the word "zinc" is used without qualification it means primary zinc.

The primary zinc produced from domestic ores in 1919 was valued at $66,032,000, based on the average selling price, as compared with $89,618,000 in 1918—a decrease of 26 per cent. The quantity decreased 8 per cent.

INTRODUCTION.

Owing to necessary economies in Government printing it has been deemed advisable to eliminate the notes which have heretofore been published to explain the tables in these reports. For the same reason the period covered by the tables, with a few exceptions, has been limited to the years 1914–1919, and some tables have been omitted. The reader will find the full notes in the chapter on zinc in Mineral Resources for 1918.

PRODUCTION.

The smelting of zinc in the United States began in an experimental way in 1858, and regular production began in 1860 at the Lehigh Zinc Works in the East and at the Matthiessen & Hegeler Works in the West. Annual statistics have been collected by the United States Geological Survey since 1882, and the progress of the zinc-smelting industry has been fully recorded in these reports.

PRIMARY ZINC.

Primary zinc produced in the United States, 1914–1919, in short tons.[a]

Apportioned according to source of ore.

	1914	1915	1916	1917	1918	1919
Total domestic	343,418	458,135	564,338	584,597	492,405	452,272
Foreign:						
Canada	4,538	5,103	24,376	6,787	8,700	4,007
Mexico	5,093	13,943	20,694	40,360	14,043	8,083
Europe	.....	1,073	12,379	11,689	113	.....
Africa	.....	.....	2,016	.....	.....	.....
Asia	.....	1,030	1,905	.....	.....	.....
Australia	.....	10,235	41,958	26,140	1,780	630
Other countries	.....	.....	677	.....	886	751
Total foreign	9,631	31,384	104,005	84,976	25,522	13,471
Total primary	353,049	489,519	668,343	669,573	517,927	465,743

Apportioned according to locality at which reduced.

Arkansas	.....	.....	7,503	25,660	26,753	31,437
Illinois	127,946	159,958	181,433	172,489	141,844	118,458
Kansas	44,510	101,423	141,286	76,048	29,149	43,942
Oklahoma	91,367	109,208	168,206	204,394	139,066	121,988
Pennsylvania	28,095	44,167	76,545	86,995	77,342	67,521
Other States	61,131	74,763	93,370	103,987	103,773	82,397
	353,049	489,519	668,343	669,573	517,927	465,743

[a] Primary zinc is made directly from ore, secondary zinc is recovered from drosses, galvanizers' ashes, old metal, and like sources.

DISTILLED AND ELECTROLYTIC ZINC.

Selected secondary zinc materials, such as zinc ashes and scrap, carefully redistilled, yield zinc of all grades, which enters the market for practically all purposes. Considerable secondary material is mixed with ore and used by some regular ore smelters. Though the quantity of metal so derived can be calculated by the smelters and thus eliminated from the output of primary zinc, it is practically impossible to segregate the redistilled secondary zinc by grades or in smelter stocks. Hence the smelter stocks as given contain some secondary zinc, and the statistics of production of zinc by grades as given in the table below likewise include secondary zinc. The quantity of secondary zinc included in the graded zinc is given in the first part of the table, which gives the source of the graded zinc by the methods of reduction. The growing output of electrolytic zinc is shown.

Distilled and electrolytic zinc produced in the United States, 1914–1919, in short tons.

Apportioned according to method of reduction.

	1914	1915	1916	1917	1918	1919
Electrolytic	.....	252	[a] 11,116	[a] 25,209	[a] 38,916	27,056
Distilled primary	353,049	489,267	657,227	644,364	479,011	438,687
Redistilled secondary zinc	20,545	29,764	28,776	16,835	9,918	19,748
	373,594	519,283	697,119	686,408	527,845	485,491

[a] Prime western zinc refined by electrolysis in addition: In 1916, 1,800 tons; in 1917, 1,701 tons; in 1918, 753 tons.

Distilled and electrolytic zinc produced in the United States, 1914–1919, in short tons—Continued.

Apportioned according to grade.

	1914	1915	1916	1917	1918	1919
Grade A (high grade, 1914–1916)	19,385	54,056	73,405	97,707	129,344	45,377
Grade B (intermediate, 1914–1916)	32,076	69,751	94,825	69,189	68,987	39,173
Grade C (select and brass special, 1914–1916)	68,551	93,131	100,875	148,749	98,584	140,917
Grade D (prime western)	253,582	302,345	428,014	370,763	230,930	260,024
	373,594	519,283	697,119	686,408	527,845	485,491

ROLLED ZINC.

A canvass of the industry by the United States Geological Survey gives the statistics presented in the following table. If the figures showing exports, as published by the Bureau of Foreign and Domestic Commerce, are subtracted from the figures showing production, the result will represent the apparent domestic consumption.

Zinc rolled in the United States, 1918–19.

	1918	1919
Zinc sheets:		
Quantity.....pounds..	79,745,237	56,514,868
Value	$12,611,294	$6,023,773
Average price per pound	$0.158	$0.107
Boiler plates and special sheets:		
Quantity.....pounds..	14,223,673	5,083,137
Value	$1,912,578	$521,389
Average price per pound	$0.134	$0.103
Zinc strips:		
Quantity.....pounds..	45,804,915	46,995,742
Value	$6,381,582	$4,902,407
Average price per pound	$0.139	$0.104
Total rolled zinc:		
Quantity.....pounds..	139,773,825	108,593,747
Value	$20,905,454	$11,447,569
Average price per pound	$0.150	$0.105
Rolled zinc exported:		
Quantity.....pounds..	27,750,910	39,524,516
Value	$4,566,756	$5,212,002
Average price per pound	$0.165	$0.132
Apparent consumption of rolled zinc.....pounds..	112,022,915	69,069,231

ZINC DUST.

Zinc dust has been marketed by domestic smelters since 1910.

Zinc dust produced in the United States, 1914–1919.

Year.	Production.					
	Prepared "blue powder."			Zinc dust "atomized."		
	Quantity (short tons).	Value.[a]	Average selling price per pound.	Quantity (short tons).	Value.[a]	Average selling price per pound.
914	1,004	$184,736	$0.092	.....	.....	.....
915	1,755	940,680	.268	.....	.....	.....
916	2,548	1,097,397	.215	61	$26,230	$0.215
917	3,989	1,322,196	.166	1,924	642,782	.167
918	4,016	877,171	.109	2,979	773,746	.130
919	[b]4,083	801,366	.098	[b]2,515	524,694	.104

[a] Value is calculated from the total value of material sold during year.
[b] Of the total output of zinc dust 385 tons of blue powder and 676 tons of "atomized" zinc dust was made om secondary zinc materials.

ZINC PIGMENTS.

Zinc forms the base, either in whole or in part, of four white pigments—zinc oxide, leaded zinc oxide, zinc-lead oxide, and lithopone. For reasons explained in previous chapters on zinc, the output of zinc oxide and leaded zinc oxide has not been published.

Lithopone produced and marketed in the United States, 1914–1919, in short tons.

1914	32,819	1917	63,713
1915	46,494	1918	62,403
1916	51,291	1919	78,365

The zinc content of the pigments made in the United States from ore, both domestic and foreign, for the period 1914–1919, is given in the first table below, and statistics of a portion of the secondary zinc recovered in the form of pigments are given in the second table.

Primary zinc content of zinc pigments made in the United States, 1914–1919, in short tons.

1914	70,619	1917	97,573
1915	79,572	1918	102,778
1916	90,276	1919	96,817

SECONDARY ZINC.

In the table below the secondary zinc [1] recovered by redistillation is separated from that recovered by remelting. The canvass of remelted zinc was made by J. P. Dunlop, of the United States Geological Survey.

Secondary zinc produced in the United States, 1914–1919, in short tons.

	1914	1915	1916	1917	1918	1919
Secondary zinc, redistilled	20,545	29,764	28,776	16,835	9,918	19,748
Secondary zinc, remelted	22,424	23,136	21,037	14,565	17,190	20,162
Recovered zinc in alloys, excluding old brass remelted	3,914	5,300	2,600	4,800	11,082	6,062
Recovered zinc in remelted brass (estimated)	24,759	34,375	61,700	80,000	82,400	62,400
Secondary zinc recovered as metal	71,642	92,575	114,100	116,200	120,600	108,400
Secondary zinc recovered in zinc dust						955
Secondary zinc recovered in pigments	6,536	8,323	8,749	9,204	8,675	10,702
Secondary zinc recovered in zinc chloride[a]	6,429	7,860	6,319	6,248	7,348	10,273
Total secondary zinc	84,607	108,758	129,200	132,000	137,000	130,300

[a] These figures include only the quantity of zinc chloride used in wood preservation and were furnished by courtesy of the Forest Service, Department of Agriculture.

MINE PRODUCTION.

The preceding tables give the quantity of zinc recovered either as metal by smelting and by electrolytic reduction, or in zinc dust, or as zinc in pigments. The following table shows the origin of the domestic zinc that is recovered by metallurgic operations. The origin of the zinc by States is obtained more accurately from the mines reports, because smelters necessarily treat mixtures of ores, sometimes long after they have been received, so that the actual

[1] See page 653 for definition of secondary zinc.

output of metallic zinc may not correspond at all closely to the product of the mines for the same year. The data for the tables of mine production are taken from the mines reports on gold, silver, copper, lead, and zinc in the different States, as indicated in the prefatory note.

Mine production of zinc in the United States, 1914–1919, in short tons.

State.	1914	1915	1916	1917	1918	1919
Arizona	4,896	9,110	9,839	10,447	1,135	859
Arkansas	608	3,209	6,815	6,691	951	189
California	195	6,547	7,628	5,436	2,781	236
Colorado	48,387	52,297	67,143	60,158	44,567	18 610
Idaho	21,006	35,077	43,253	39,927	22,581	7,997
Illinois	4,811	5,534	3,404	4,267	3,792	6,788
Iowa	.....	.....	21	18	.....	.....
Kansas	11,284	14,365	12,448	20,249	30,197	47,636
Kentucky	230	764	1,096	751	315	36
Missouri	105,994	136,300	155,960	132,918	55,992	31,540
Montana	55,790	93,573	114,630	93,130	104,629	84,382
Nevada	6,490	12,188	16,222	11,154	8,362	4,502
New Hampshire	6	24	36	45	14	.....
New Jersey	82,956	117,722	112,020	120,846	98,470	92,912
New Mexico	9,202	12,702	18,285	15,100	12,025	3,797
New York	.....	2,455	4,507	5,192	3,776	5,120
Oklahoma	13,992	14,314	28,754	85,835	161,401	178,410
Tennessee	10,425	16,461	26,428	28,498	21,071	23,247
Texas	108	15	116	11	.....	.....
Utah	7,995	12,146	14,786	10,643	9,200	2,216
Virginia	174	1,267	2,276	1,703	951	.....
Washington	.....	122	847	598	19	.....
Wisconsin	31,113	41,403	56,803	59,742	50,014	40,765
Total	415,662	587,595	703,317	713,359	632,243	549,242

ZINC-SMELTING CAPACITY AND CHANGES IN 1919.

The number of retorts at zinc smelters at the end of 1919 was 157,004. There were no additional retorts under construction; in fact, at several smelters it was intended to curtail operations after the end of the year. The number of retorts in operation was 107,500 at 34 plants, compared with 82,000 retorts in operation at the middle of 1919 and with 123,500 retorts in operation at 36 plants at the beginning of 1919.

TRADE CONDITIONS.

WORLD'S PRODUCTION.

The following statistics, though incomplete, show approximately the foreign production during the war. The figures in black-faced type are taken from the official statistics of the countries named; those in the ordinary type are taken from statistical handbooks, consular reports, market letters, and trade journals. There is always a possibility of duplication in figures showing European production, for some countries send crude zinc of poor quality to other countries for refining. Furthermore, secondary zinc is included in the figures showing the foreign production, so that to put the United States on an equal footing in the statistics it would be necessary to include in its production the domestic output of secondary zinc.

World's production of zinc, 1913–1919.

[In metric tons, by countries where smelted.]

Country.	1913	1914	1915	1916	1917	1918	1919
Australia:							
Tasmania					49	3,883	3,727
Mainland	4,187	5,094	5,393	5,362	4,769	5,712	3,625
Austria	21,707	15,068	9,472	11,642	12,633	12,012	(a)
Belgium	204,220	145,925	51,660	22,930	10,290	9,245	19,860
Canada			20	2,698	9,058	11,139	11,182
China	(a)	(a)	(a)	(a)	(a)	(a)	(a)
France	67,890	42,473	19,180	20,258	22,929	18,347	10,800
Germany:							
Upper Silesia	169,439	141,761	121,851	122,489	128,832	122,961	74,023
Other Germany	113,674	94,000	65,000	55,000	57,000	53,000	(a)
Great Britain	66,243	50,000	45,000	60,000	50,000	50,000	35,000
Italy				258	367	1,188	1,282
Japan	900	5,881	21,132	38,994	54,718	40,000	20,000
Netherlands	24,323	16,453	11,130	12,101	4,059	681	
Norway	9,287	18,995	24,993	31,991	21,993	20,000	3,400
Russia	10,500	6,300	2,000	1,100	(a)	(a)	2,500
Siberia				213	569	(a)	(a)
Spain	6,003	11,733	8,117	8,523	10,155	15,900	16,314
Sweden	2,115	2,300	8,588	9,997	7,979	4,098	2,321
United States	314,498	320,279	444,082	606,307	607,423	469,853	422,513
	1,015,000	876,000	838,000	1,010,000	1,003,000	838,000	627,000

a Statistics not available.

IMPORTS AND EXPORTS.

The following tables of imports and exports of zinc and of zinc remaining in warehouses are made up from the publications and records of the Bureau of Foreign and Domestic Commerce of the Department of Commerce.

ZINC REMAINING IN WAREHOUSE.

The quantity of zinc remaining in warehouse at the end of each year prior to 1909 has been negligible, but since all zinc ore became dutiable, on August 6, 1909, the quantity of bonded zinc has largely increased. The large imports of foreign zinc ore on account of the demand for munitions greatly swelled the quantity remaining in warehouse December 31, 1915 and 1916, as will be seen in the accompanying tables.

Zinc remaining in warehouse in the United States, Dec. 31, 1914–1919.

Year.	Ore and calamine.			Blocks, pigs, and old.		Zinc dust.	
	Quantity (short tons).	Zinc content (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1914	6,728	6,987,676	$90,257	221,994	$11,100	272,915	$13,005
1915	63,168	43,691,611	1,628,509	63,892	4,028	115,375	8,815
1916	82,227	57,259,940	2,210,286	180,026	14,301	120,921	12,989
1917	96,560	53,997,636	1,177,680	63,545	3,949	64,812	5,710
1918	(a)	53,766,247	1,089,560				
1919	(a)	37,696,007	674,384				

a Figures not available.

IMPORTS.

Zinc imported and entered for consumption in the United States, 1914–1919.

Year.	Blocks or pigs.		Sheets.		Old.		Value of manufactures.	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1914	195	$21,140	277	$32,004	388	$26,512	$4,464	$84,120
1915	63	16,864	95	14,407	729	103,294	622	135,187
1916	21	4,436	2	432	642	112,254	829	117,951
1917	18	2,279	73	16,570	259	25,974	250	45,073
1918	11	2,897	.....	29	24	2,056	331	5,313
1919	32	2,284	1	249	37	2,216	1,258	6,007

Zinc dust, zinc oxide, and lithopone, imported and entered for consumption in the United States, 1914–1919.

Year.	Zinc dust.		Zinc oxide.				Lithopone.[a]	
			Dry.		In oil.			
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.
1914	2,004	$191,582	2,461	$279,642	168	$23,196	4,036	$277,822
1915	707	137,474	853	148,220	29	5,929	2,126	144,567
1916	522	230,380	447	181,319	18	4,076	2,372	414,592
1917	233	48,604	119	52,649	5	876	229	35,718
1918	16	3,552	162	62,703	4	1,043	1	993
1919	52	5,753	105	44,338	3	1,351	744	127,121

[a] This heading includes imports of lithopone and "zinc sulphide white." The imports for 1918 consisted of 2,670 pounds of "zinc sulphide white" and no lithopone—hence the high value.

General imports of old brass fit only for remanufacture, 1914–1919.

[Average composition about one-third zinc and two-thirds copper.]

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1914	2,450	$487,542	1917	27,580	$9,931,721
1915	8,354	1,809,550	1918	6,115	1,774,002
1916	22,976	6,578,809	1919	7,938	2,157,948

The following figures are taken directly from the Monthly Summary of the Bureau of Foreign and Domestic Commerce without the liquidation correction:

General imports of zinc ore into the United States, 1904–1919.

Year.	1904–1917							
	Canada.		Mexico.		Other countries.		Total.	
	Ore (short tons).	Zinc content (short tons).	Ore (short tons).	Zinc content (short tons).	Ore (short tons).	Zinc content (short tons).	Ore (short tons).	Zinc content (short tons).
1904	.....	.....	2,264	.....	.....	.....	2,264	.....
1905	4,063	.....	18,074	.....	.....	.....	22,137	.....
1906	423	.....	54,991	.....	.....	.....	55,414	.....
1907	1,112	.....	102,005	.....	.....	.....	103,117	.....
1908	7,406	.....	46,351	.....	.....	.....	53,757	.....
1909	10,024	.....	104,826	.....	.....	.....	114,850	.....
1910	4,749	1,922	67,877	23,517	.....	.....	72,626	25,439
1911	2,359	947	36,757	14,986	.....	.....	39,116	15,933
1012	8,015	3,661	35,925	13,606	.....	.....	43,940	17,267
1913	8,899	3,498	17,476	6,160	5,041	3,839	31,416	13,497
1914	11,250	4,467	20,705	7,663	7	2	31,962	12,132
1915	11,992	4,710	57,699	17,804	89,161	35,155	158,852	57,669
1916	21,908	8,790	161,271	51,028	202,785	88,329	385,964	148,147
1917	16,559	5,155	145,358	45,697	49,678	21,622	211,595	72,474

Country.	1918			1919		
	Ore (short tons).	Zinc content (short tons).	Value.	Ore (short tons).	Zinc content (short tons).	Value.
Canada	14,987	5,173	$319,815	10,656	3,878	$115,974
Mexico	53,348	18,426	1,202,035	33,443	11,225	346,040
Chile	2,444	1,149	49,560	4,550	1,906	67,646
Argentina	123	61	2,559	.....	.....	.....
	70,902	24,809	1,573,969	48,649	17,009	529,660

The sources of the large quantities of zinc ores imported from "Other countries" in 1915–1917, inclusive, are given in Mineral Resources, 1918, page 1066.

EXPORTS.

DOMESTIC EXPORTS.

Domestic zinc ore and domestic manufactures of zinc exported from the United States, 1914–1919.

Year.	Zinc ore.		Pigs or slabs.		Plates and sheets.		Zinc dross.		All other manufactures.[a]	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Quantity (short tons).	Value.	Value.	
1914	[b]11,110	$388,464	[c]64,802	[c]$8,540,668	(c)	(c)	2,536	$240,944	$210,908	$9,380,984
1915	[b]832	35,276	[c]118,603	[c]29,537,680	(c)	(c)	4,167	506,956	1,951,949	32,031,861
1916	78	3,992	150,623	46,770,901	12,512	$4,540,146	48	10,801	574,229	51,900,069
1917	1,320	63,043	137,282	32,605,767	16,514	5,730,792	13,302	2,126,909	570,352	41,096,863
1918	62	2,480	66,369	12,469,622	13,875	4,566,756	15,816	2,238,913	722,671	20,000,442
1919	.....	.....	109,746	17,524,153	19,762	5,212,002	5,123	739,295	538,133	24,013,583

[a] Not including brass.
[b] The exports consisted wholly of high-grade willemite ore from New Jersey.
[c] Plates and sheets included with pigs or slabs.

Zinc oxide exported from the United States, 1914–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1914	15,592	$1,408,525	1917	15,446	$3,148,898
1915	19,989	2,068,428	1918	12,421	2,779,507
1916	13,942	2,394,709	1919	14,703	3,059,276

Domestic brass and brass manufactures exported from the United States, 1914–1919.

[Zinc content approximately 30 per cent by weight.]

Year.	Bars, plates, and sheets.		Scrap and old.		Articles made from (value).	Total value.
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1914	3,558	$909,153	10,320	$2,100,870	$3,756,888	$6,766,911
1915	33,136	12,435,782	5,628	1,259,637	41,146,025	54,841,444
1916	122,266	72,683,626	3,478	1,305,050	241,668,081	315,656,757
1917	164,173	101,521,426	4,149	1,758,384	136,611,299	239,891,109
1918	15,495	9,522,934	2,455	799,318	19,483,146	29,805,398
1919	3,885	2,310,561	661	176,028	11,426,289	13,912,878

FOREIGN EXPORTS.

Foreign zinc exported from the United States in 1914–1919.

Year.	Exported from warehouse.					Exported in manufactures with benefit of drawback, slabs and sheets excluded (short tons).
	Ore and calamine, zinc content.		Blocks, pigs, and old.		All other manufactures (value).	
	Quantity (short tons).	Value.	Quantity (short tons).	Value.		
1914	140	$5,909	5,580	$218,145	$18,544	4,128
1915	.....	.....	12,775	2,355,557	119,104	32
1916	.....	.....	43,230	8,080,442	1,072	.....
1917	.....	.....	64,680	12,429,356	50	1,588
1918	.....	.....	20,069	3,565,127	.....	6,337
1919	.....	.....	12,256	1,943,507	13,071	4,533

CONSUMPTION.

APPARENT CONSUMPTION OF PRIMARY ZINC.

In the following table only zinc made from ore—that is, primary zinc—is taken into account.

Primary zinc consumed in the United States, 1914–1919, in short tons.

	1914	1915	1916	1917	1918	1919
Supply:						
Stock Jan. 1:						
In bonded warehouses	.....	111	32	90	32	.....
At smelters	40,659	19,984	14,221	17,508	53,689	41,241
Production	353,049	489,519	668,343	669,573	517,927	465,743
Imports	880	904	684	257	35	70
Total available	394,588	510,518	683,280	687,428	571,683	507,054
Withdrawn:						
Exports, foreign, from warehouse	5,580	12,775	43,230	64,680	20,069	12,256
Exports, foreign, under drawback	4,128	32	.....	1,588	6,337	4,533
Exports, domestic	64,802	118,603	163,135	153,796	80,244	129,508
Stock Dec. 31:						
In bonded warehouses	111	32	90	32	.....	.....
At smelters	19,984	14,221	17,508	53,689	41,241	36,793
Total withdrawn	94,605	145,663	223,963	273,785	147,891	183,090
Apparent consumption	299,983	364,855	459,317	413,643	423,792	323,964

CONSUMPTION OF ZINC IN GALVANIZING.

Statistics of the output of galvanized sheets, galvanized formed products made from iron or steel sheets, and galvanized wrought iron and steel pipe are gathered by the American Iron and Steel Institute from all the manufacturers of these products and are published yearly. Other classes of galvanized products, such as wire, barbed wire, cast and forged products, nails, spikes, and bolts are not taken into statistical account by the Institute. As described on pages 1071 and 1072 of the chapter on zinc for 1918 a fairly close estimate can be formed of the quantity of zinc used in coating these reported products, and, though only a part of the zinc consumed in galvanizing is represented, a comparison of the yearly figures gives a good idea of the relative condition of the galvanizing industry.

Galvanized iron and steel sheets, formed products, and pipe produced in the United States, 1914–1919, in short tons, with an estimate of the quantity of zinc used in galvanizing them.

	1914	1915	1916	1917	1918	1919
Galvanized iron and steel sheets[a]	903,834	790,785	673,462	636,989	579,889	750,288
Galvanized formed products [a b]	65,802	56,096	65,151	57,451	60,555	70,247
Galvanized pipe [a]	296,832	314,657	325,935	308,342	296,444	300,335
	1,266,468	1,161,538	1,064,548	1,002,782	936,888	1,120,870
Zinc used (estimated)	151,976	139,385	127,746	120,334	112,427	134,504

[a] From annual statistical reports of American Iron and Steel Institute.
[b] Articles formed or stamped from iron or steel sheets and galvanized after shaping.

PRICES.

The price quoted at the beginning of 1919 for prime western zinc for immediate delivery at St. Louis was 7.7 cents a pound, having declined to that point from 9.5 cents in September of 1918. The decline continued until May, 1919, when the price reached 6 cents. There was a brisk recovery to 8 cents in the later part of July, after which a slight recession carried the price down to 7 cents in September. A rise brought the metal up to 8.85 cents at the

end of the year. The average quoted price for the year for prime western zinc at St. Louis was 7 cents.

Experience has shown that large sales of zinc for future delivery at considerable variations in price, as well as the sales of metal of better grades than prime western at much higher prices than that grade, render the average price quoted for prime western zinc an unsafe guide to the average value of all zinc sold. A canvass of the actual sales of zinc and the prices received in 1919 gives 7.3 cents a pound as the average selling price of all grades—A, B, C, and prime western—which may be compared to 7 cents, the average quoted price at St. Louis for prime western metal. The average selling price for all grades is the price used in calculating the value of the zinc output of the country. The table below gives the average selling price of each grade of zinc in 1917–1919 and the average selling price for all grades since 1915, as calculated from the total receipts from sales by producers; in addition the price of high-grade metal is given for 1914–1916.

The official price of high-grade metal, fixed by the War Industries Board February 13, 1918, as 12 cents a pound f. o. b. car at East St. Louis, ceased to be in force at the end of 1918, and metal of that grade dropped in value on account of the stocks owned by smelters and the Government. The production and stocks of the different grades of zinc for the first quarter of 1919 are shown graphically in figure 18 on page 1047 of Mineral Resources for 1918, Part I. Stocks of high-grade metal continued to increase and the price decreased during the quarter, so that the high-grade metal was quoted in April at only a fraction of a cent over prime western. The average selling price for the year of grade A metal was 8.3 cents a pound.

Zinc opened the year in London at the fixed price of £56 a long ton (12 cents a pound) and remained at that point through January, after which it fell rapidly to £37 10s. a long ton (8.1 cents a pound) in March. It rose to £43 5s. (8.4 cents a pound) in July and then dropped in August to £37 15s. a long ton (7.3 cents a pound), a little below the St. Louis price. A gradual rise brought the metal at the end of the year to £56 17s. 10d. a long ton (9.7 cents a pound), in English currency slightly above the fixed price at the opening of the year, but in United States currency, owing to the depreciation of the exchange rate, about 2¼ cents a pound less.

The fixed price of rolled zinc in 1918 was 15 cents a pound, but with an open market in January, 1919, the price dropped to 13 cents and by stages to 10 cents in March. Three advances of half a cent each brought the price up to 11.5 cents at the end of the year. The average quoted base price of sheets for the year was 11.1 cents a pound, whereas the average price received for sheets as calculated from sales was 10.7 cents. The average price received for all rolled zinc sold during the year was 10.5 cents as compared with 15 cents in 1918. Prices of the different classes of rolled zinc in 1918 and 1919 are given on page 655.

Zinc dust at the beginning of 1919 was quoted at 13 to 15 cents a pound, the price depending on quality. The price dropped to 8.5 to 10 cents by April and remained at that point until the middle of November. During the remainder of the year the quotation was 11 to 13 cents a pound. The average of quotations for the year is 10.9 cents. The average price received during the year as reported by the producers is shown on page 655 and was 9.8 cents for prepared "blue powder" and 10.4 cents for "atomized" zinc dust.

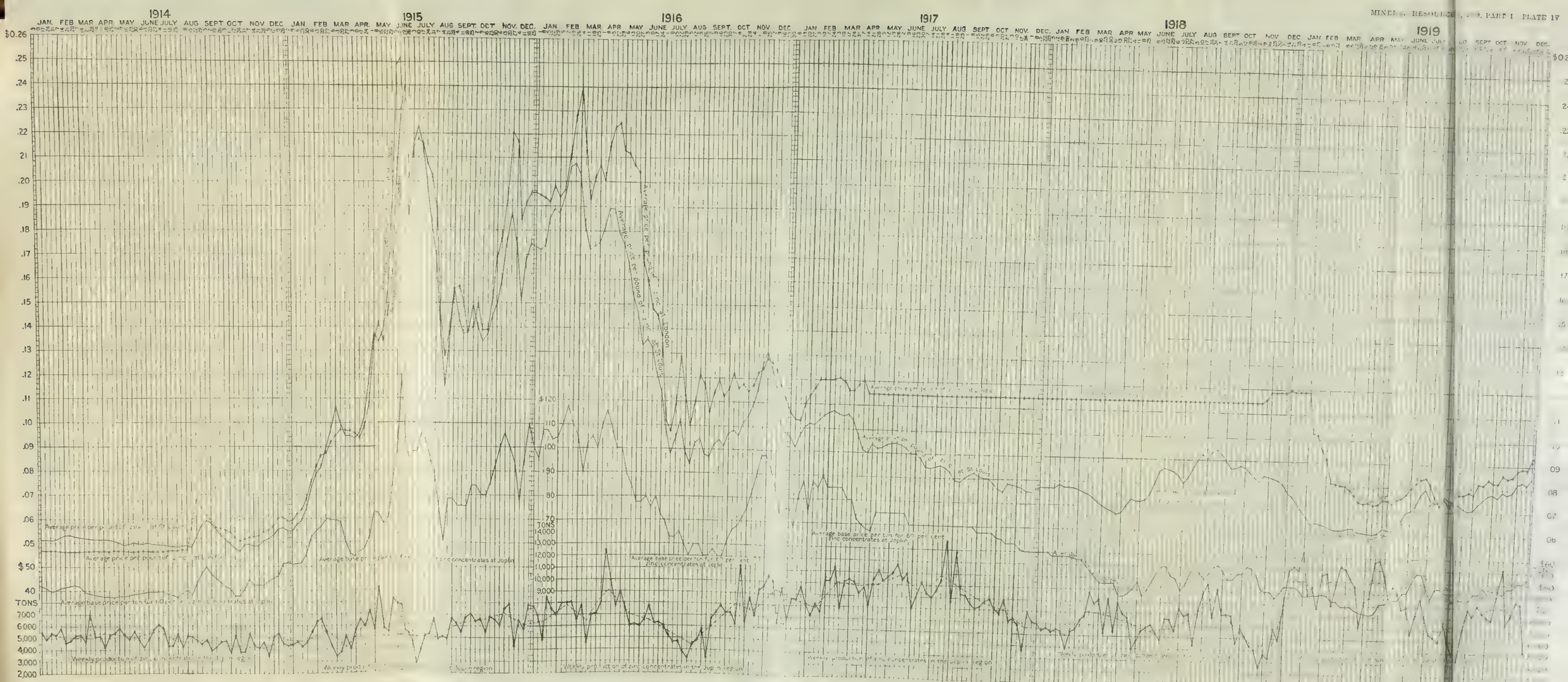
Prices of zinc, by grades, 1914–1919.

[In cents per pound; average price received except as otherwise stated.]

	1914	1915	1916	1917	1918	1919
Grade A (high grade of 1913–1916)	[a] 8.0	[a] 31.1	[a] 23.2	14.0	11.1	8.3
Grade B (intermediate of 1913–1916)	.....	.....	.....	12.7	10.7	7.7
Grade C (select and brass special of 1913–1916)	.....	.....	.....	9.4	8.0	7.2
Grade D (prime western)	.....	.....	.....	9.0	7.9	7.1
All grades	.....	12.4	13.4	10.2	9.1	7.3
Prime western, average spot quotation at St. Louis	5.1	14.2	13.6	8.9	8.0	7.0

[a] Am. Zinc Inst. Bull., vol. 3, No. 3, p. 7, 1920; averaged from monthly prices.

Plate IV shows graphically for the years 1914–1919 the relations of the weekly average St. Louis quoted price of zinc, the weekly average London price of zinc, the weekly average price of 60 per cent zinc blende concentrates at Joplin, Mo., and the weekly sales of concentrates in the Joplin region as a whole. The price of zinc has been taken from market reports, and the price of zinc blende and the figures of weekly sales are those published in the Joplin daily papers. To eliminate the sharp weekly fluctuations and to obtain a curve more easily comparable with the price curves, the weekly sales have been averaged by months, the result being shown by the broken lines.



AVERAGE WEEKLY PRICE OF ZINC AT ST. LOUIS AND LONDON AND OF 60 PER CENT ZINC CONCENTRATES AT JOPLIN, AND WEEKLY PRODUCTION (SALES) OF ZINC CONCENTRATES IN THE JOPLIN REGION, 1914-1919.

The broken line shows the weekly production (sales) in the Joplin region, averaged by months.

GOLD AND SILVER.

(GENERAL REPORT.)

By J. P. Dunlop.

PRODUCTION.

DOMESTIC PRODUCTION.

Approximate distribution, by producing States and Territories, of the production of gold and silver in the United States in 1919.[a]

State or Territory.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
Alaska	481,984	$9,963,500	690,151	$773,570
Arizona	222,965	4,609,100	5,702,911	6,392,222
California	841,638	17,398,200	1,153,614	1,293,051
Colorado	495,810	10,249,300	5,966,606	6,687,790
Georgia	34	700	8	9
Idaho	34,085	704,600	5,933,076	6,650,207
Illinois			6,000	6,725
Maine	10	200	4,142	4,643
Michigan			425,610	477,054
Missouri	14	300	75,991	85,176
Montana	116,918	2,416,900	15,012,258	16,826,790
Nevada	225,384	4,659,100	7,045,395	7,896,972
New Mexico	28,319	585,400	851,821	954,781
North Carolina	5	100	19	21
Oregon	53,029	1,096,200	236,620	265,220
Philippine Islands	41,119	850,000	15,715	17,614
South Carolina	5	100	2	2
South Dakota	255,889	5,289,700	122,068	136,822
Tennessee	271	5,600	97,554	109,345
Texas	19	400	539,483	604,690
Utah	109,661	2,266,900	12,542,623	14,058,650
Vermont	19	400	2,200	2,466
Virginia			8	9
Washington	11,436	236,400	258,270	289,487
Wyoming	14	300	300	336
	2,918,628	60,333,400	56,682,445	63,533,652

[a] Gold value, $20.67+ per fine ounce. Average commercial (dealers') buying price of silver, 0.999 fine in 1919, $1.12087 per fine ounce.

The figures in this table were obtained through cooperation between the United States Bureau of the Mint and the United States Geological Survey and were agreed upon after conference and adjustment between the two bureaus. They are therefore final for both.

The totals are based on bullion deposits in the United States mints and assay offices and on returns to the Bureau of the Mint from the smelting and refining companies. The distribution is adjusted by means of information collected by the United States Geological Survey directly from the producing mines, and tabulated for the mines reports later discussed. The data for the total production and in part for the

distribution are obtained from records of (1) the unrefined domestic gold and silver deposited in United States mints and assay offices, (2) the domestic gold and silver in fine bars reported by private refineries, and (3) the unrefined domestic gold and silver contained in ores and matte exported for reduction. The last item is relatively small.

Increase or decrease in production of gold and silver in the United States in 1919.

State or Territory.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
Alabama	− 34	− $700	− 2	− $2
Alaska	+ 26,064	+ 538,800	− 112,592	− 13,487
Arizona	− 47,113	− 973,900	−1,128,554	− 305,756
California	+ 29,693	+ 613,800	− 279,198	− 111,764
Colorado	−119,748	−2,475,400	− 933,660	− 77,645
Georgia	− 184	− 3,800	− 37	− 35
Idaho	+ 155	+ 3,200	−3,462,933	−2,562,204
Illinois			− 2,218	− 1,332
Maine and New Hampshire	− 24	− 500	− 2,887	− 2,249
Maryland			− 164	− 161
Michigan			− 90,684	− 29,152
Missouri	+ 11	+ 240	+ 33,777	+ 43,787
Montana	− 41,786	− 863,800	−1,366,005	+ 768,558
Nevada	− 98,750	−2,041,340	−2,886,574	−1,840,926
New Mexico	− 4,918	− 101,680	+ 78,159	+ 196,236
North Carolina	− 208	− 4,300	− 81	− 77
Oregon	− 8,199	− 169,500	+ 107,470	+ 138,594
Philippine Islands	− 21,285	− 440,000	+ 2,715	+ 4,868
Porto Rico	− 5	− 100		
South Carolina	+ 5	+ 100	+ 2	+ 2
South Dakota	− 68,194	−1,409,700	− 39,164	− 21,260
Tennessee			− 8,275	+ 5,584
Texas	+ 18	+ 380	− 39,675	+ 36,849
Utah	− 42,865	− 886,100	− 949,932	+ 829,739
Vermont	− 29	− 600	− 2,691	− 2,329
Virginia	− 19	− 400	− 1,806	− 1,770
Washington	− 4,712	− 97,400	− 41,730	− 4,651
Wyoming	− 29	− 600	− 955	− 894
Decrease	402,156	8,313,300	11,127,694	2,951,477

Domestic smelters and refiners produced 2,918,628 fine ounces of gold and 56,682,445 fine ounces of silver from domestic sources in 1919, also 668,161 fine ounces of gold and 57,806,123 fine ounces of silver from foreign ores and bullion, an increase of 101,275 ounces of gold and 1,826,703 ounces of silver compared with the corresponding figures for 1918. The foreign ores came mainly from Mexico, Canada, and Peru.

The value of the new gold used in the arts and industries in the United States in 1919 was $56,135,951, compared with $32,892,395 in 1918, and the quantity of silver used for such purposes was 26,237,519 fine ounces, compared with 26,722,333 ounces. The consumption of new silver in the arts and industries in 1919 was equal to 46 per cent of the domestic production and that of gold to 93 per cent of the domestic production. In addition to the gold and silver derived from foreign and domestic ores and bullion $19,354,398 of gold and 6,463,002 fine ounces of silver were recovered from old jewelry, dental waste, silverware, and other old material. The value of all the new and old gold used in the arts and industries in 1919 was more than $75,000,000, which exceeded the value of the domestic output from mines by more than $15,000,000.

PRICES OF SILVER.

The average official monthly prices of fine bar silver in New York in 1919 were as follows:

Prices of silver per fine ounce in 1919, by months.[1]

January	$1.01558	August	$1.12386
February	1.01500	September	1.15636
March	1.01495	October	1.20692
April	1.01500	November	1.30446
May	1.08020	December	1.33072
June	1.11402		
July	1.07332	Yearly average	1.12087

The average annual price of silver per fine ounce from 1865 to 1919, inclusive, has been as follows:

Price of silver per fine ounce, 1865–1919.[2]

1865	$1.337	1884	$1.11	1903	$0.54
1866	1.339	1885	1.07	1904	.58
1867	1.33	1886	.99	1905	.61
1868	1.326	1887	.98	1906	.68
1869	1.325	1888	.94	1907	.66
1870	1.328	1889	.94	1908	.53
1871	1.325	1890	1.05	1909	.52
1872	1.322	1891	.99	1910	.54
1873	1.297	1892	.87	1911	.53
1874	1.278	1893	.78	1912	.615
1875	1.24	1894	.63	1913	.604
1876	1.16	1895	.65	1914	.553
1877	1.20	1896	.68	1915	.507
1878	1.15	1897	.60	1916	.658
1879	1.12	1898	.59	1917	.824
1880	1.15	1899	.60	1918	.980
1881	1.13	1900	.62	1919	1.12
1882	1.14	1901	.60		
1883	1.11	1902	.53		

PRODUCTION OF GOLD AND SILVER SINCE 1792.

Gold and silver produced in the United States, 1792–1919.

The estimate for 1792–1872 is by R. W. Raymond, commissioner, and for the period since 1872 by the Director of the Mint.]

Period.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
1792–1847	a 1,186,977	$24,537,000	309,500	$404,500
1848–1872	a 58,279,781	1,204,750,000	118,568,200	157,749,900
1873–1919	136,049,899	2,812,401,000	2,385,152,323	1,866,878,081
	195,516,657	4,041,688,000	2,504,030,023	2,025,032,481

a Revised figure.

[1] This represents average official quotations for sale by the mint and is above dealers' prices for silver .999 fine.

[2] Based on London price of bar silver 1.000 fine and taken at average price and par of exchange, 1865–1915; New York dealers' buying price for 1916–1919.

Although the output of gold was less than one-twelfth the output of silver in quantity, its value was about twice that of the silver.

The average commercial value per fine ounce of silver for the 127 years contributing to the total domestic production was nearly $0.81. Fluctuations in value of silver per fine ounce are shown in the curve in figure 10. For the years shown (1871 to 1919, inclusive), the average annual value was more than $0.80 before 1893, and it has been less than that figure every year since until 1917, when it was $0.82; 1918, when it was $0.98; and 1919, when it was $1.12.

Gold and silver produced in the United States, 1880–1919.

Year.	Gold.		Silver.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Commercial value.
1880	1,741,500	$36,000,000	30,318,700	$34,717,000
1881	1,678,612	34,700,000	33,257,800	37,657,500
1882	1,572,187	32,500,000	36,196,900	41,105,900
1883	1,451,250	30,000,000	35,732,800	39,618,400
1884	1,489,950	30,800,000	37,743,800	41,921,300
1885	1,538,373	31,801,000	39,909,400	42,503,500
1886	1,686,788	34,869,000	39,694,000	39,482,400
1887	1,603,049	33,136,000	41,721,600	40,887,200
1888	1,604,478	33,167,500	45,792,700	43,045,100
1889	1,594,775	32,967,000	50,094,500	46,838,400
1890	1,588,877	32,845,000	54,516,300	57,242,100
1891	1,604,840	33,175,000	58,330,000	57,630,000
1892	1,597,098	33,015,000	63,500,000	55,662,500
1893	1,739,323	35,955,000	60,000,000	46,800,000
1894	1,910,813	39,500,000	49,500,000	31,422,100
1895	2,254,760	46,610,000	55,727,000	36,445,500
1896	2,568,132	53,088,000	58,834,800	39,654,600
1897	2,774,935	57,363,000	53,860,000	32,316,000
1898	3,118,398	64,463,000	54,438,000	32,118,400
1899	3,437,210	71,053,400	54,764,500	32,858,700
1900	3,829,897	79,171,000	57,647,000	35,741,100
1901	3,805,500	78,666,700	55,214,000	33,128,400
1902	3,870,000	80,000,000	55,500,000	29,415,000
1903	3,560,000	73,591,700	54,300,000	29,322,000
1904	3,892,480	80,464,700	57,682,800	33,456,000
1905	4,265,742	88,180,700	56,101,600	34,222,000
1906	4,565,333	94,373,800	56,517,900	38,256,400
1907	4,374,827	90,435,700	56,514,700	37,299,700
1908	4,574,340	94,560,000	52,440,800	28,050,600
1909	4,821,701	99,673,400	54,721,500	28,455,200
1910	4,657,018	96,269,100	57,137,900	30,854,500
1911	4,687,053	96,890,000	60,399,400	32,615,700
1912	4,520,717	93,451,500	63,766,800	39,197,500
1913	4,299,783	88,884,400	66,801,500	40,348,100
1914	4,572,976	94,531,800	72,455,100	40,067,700
1915	4,887,602	101,035,700	74,961,075	37,397,300
1916	4,479,056	92,590,300	74,414,802	48,953,000
1917	4,051,440	83,750,700	71,740,362	59,078,100
1918	3,320,784	68,646,700	67,810,139	66,485,129
1919	2,918,628	60,333,400	56,682,445	63,533,652
	122,510,225	2,532,509,200	2,176,742,623	1,615,803,681

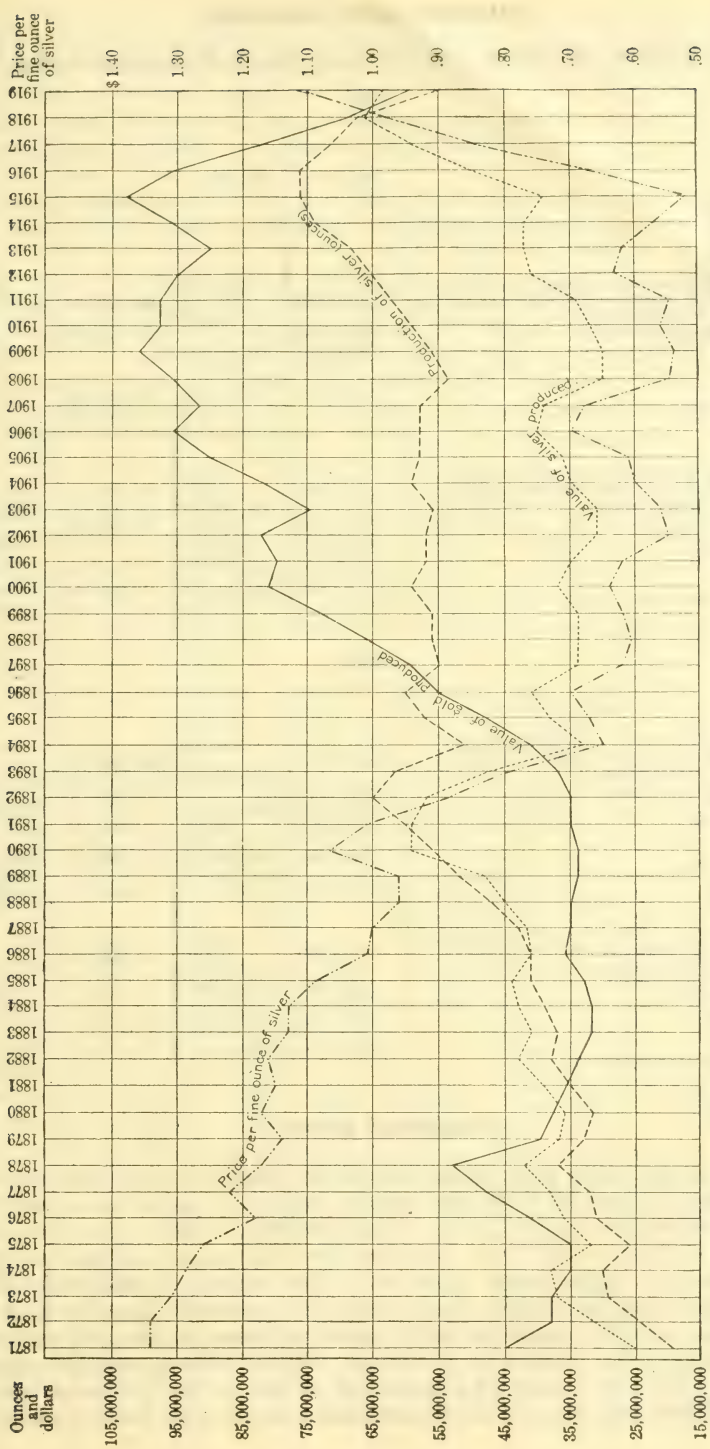


FIGURE 10.—Curves showing production and value of gold and silver and price per fine ounce of silver in the United States, 1871–1919.

IMPORTS AND EXPORTS.

Value of gold and silver imported into and exported from the United States, 1918 and 1919.

1918.

	Imports.	Exports.	Excess of—	
			Imports.	Exports.
GOLD.				
Contained in domestic ore and base bullion		$206,674		$206,674
Contained in foreign ore and base bullion	$16,251,930		$16,251,930	
Domestic bullion refined		8,052,578		8,052,578
Foreign bullion refined	38,911,037		38,911,037	
United States coin	6,743,464	32,431,889		25,688,425
Foreign coin	136,317	378,677		242,360
	62,042,748	41,069,818	55,162,967	34,190,037
Excess imports over exports			20,972,930	
SILVER.				
Contained in domestic ore and base bullion		18,248		18,248
Contained in foreign ore and base bullion	44,877,920		44,877,920	
Domestic bullion refined		236,411,329		236,411,329
Foreign bullion refined	20,619,195	6,016,337	14,602,858	
United States coin	1,267,837	3,542,926		2,275,089
Foreign coin	4,610,747	6,857,624		2,246,877
	71,375,699	252,846,464	59,480,778	240,951,543
Excess exports over imports				181,470,765

1919.

GOLD.				
Contained in domestic ore and base bullion		$20,719		$20,719
Contained in foreign ore and base bullion	$16,744,430		$16,744,430	
Domestic bullion refined		122,055,164		122,055,164
Foreign bullion refined	33,183,373		33,183,373	
United States coin	11,244,897	245,496,208		234,251,311
Foreign coin	15,361,346	613,157	14,748,189	
	76,534,046	368,185,248	64,675,992	356,327,194
Excess exports over imports				291,651,202
SILVER.				
Contained in domestic ore and base bullion		6,693		6,693
Contained in foreign ore and base bullion	74,073,332	1,252	74,072,080	
Domestic bullion refined		186,533,723		186,533,723
Foreign bullion refined	8,382,030	23,644,997		15,262,967
United States coin	1,057,135	21,224,827		20,167,692
Foreign coin	5,897,521	7,609,559		1,712,038
	89,410,018	239,021,051	74,072,080	223,683,113
Excess exports over imports				149,611,033

DOMESTIC SUPPLY.

The remarkable gain in the domestic supply of gold indicated by the great excess of $530,200,000 in imports over exports in 1916, of $180,000,000 in 1917, and of $21,000,000 in 1918, came to a halt in the early part of 1919, because few European nations had gold available to settle trade balances. The excess of gold exports in 1919 was due to adverse trade balances in South America and the Far East, and the countries which received most of the gold exported were Argentina, Venezuela, Uruguay, Japan, China, and Hongkong.

The value of excess of exports of silver in 1919, though nearly $32,000,000 less than in 1918, continued to be very heavy, owing to

the demand for exchange. The value of refined domestic silver bullion exported, mainly to China and India, exceeded $186,000,000, or about $123,000,000 more than the value of the domestic production of new silver in 1919.

The total number of silver dollars remelted to March 22, 1920, under the Pittman Act, passed by Congress in April, 1918, was 270,121,554. The purchases of silver from domestic mines in 1920 at the price fixed under the Pittman Act were as follows, in fine ounces: May, 332,088; June, 6,168,505; July, 3,288,856; August, 3,429,277; September, 3,815,933; October, 4,634,860; November, 3,638,870; December, 4,599,172; total, 29,907,561. The purchases in May, the first month in which the fixed mint price was higher than the open-market price, were comparatively small. The average monthly purchases for the remaining seven months of 1920 were about 4,220,000 fine ounces, which would be about 50,700,000 ounces a year.

If purchases continue at this rate it would take more than five years to replace the silver dollars remelted under the act. It is not probable that the purchases of domestic silver in 1920 were much more than 50,000,000 to 55,000,000 ounces, owing to the continued depression at the copper, lead, and zinc mines, for most of the domestic silver is derived from these sources. Resumption of mining at base-metal mines will greatly increase the quantity of domestic silver, but it is impossible at present to predict when the total purchases will reach the total quantity of silver necessary to replace the silver dollars remelted.

The domestic supply of new gold comes chiefly from dry or siliceous gold ores, treated mainly in gold mills by amalgamation or cyanidation, or both, and partly by smelting, and from placer gravels worked largely by dredging. As shown on page 692, these ores and placer gravels supplied 90 per cent of the yield of gold in 1919. Examples of gold milling ores are those of the Homestake mines of South Dakota, the Goldfield mines in Nevada, the Grass Valley and Mother Lode mines of California, the mines of the Juneau district in Alaska, and the Cripple Creek and upper San Miguel County mines in Colorado. The great gold-dredging fields of California, especially those of the Marysville district, are examples of placer gravels worked on a large scale. A considerable output of gold is also now recovered from the refining of copper bullion from copper ores, especially in the West Mountain or Bingham district, Utah, and the Summit Valley or Butte district, Mont. In 1919 the copper ores of the United States produced 6.8 per cent of the total gold, against 9.6 per cent in 1918. The natural tendency has been for the proportionate output from gold ores to decrease with declining yield from some of the principal gold camps and for that from copper ores to increase, with a general net falling off of total yield of gold owing to the preponderant output from gold and gold-silver ores. This tendency was suspended in 1919 owing to the large decreases in the output of copper.

The principal domestic supply of new silver came from dry or siliceous silver and silver-gold ores, copper ores, lead ores, and lead-zinc ores in the proportion of 36.7, 24.8, 27.6, 10.2 per cent, respectively, in 1919, against 31.7, 30, 26.9, and 10.7 per cent, respectively, in 1918. The dry or siliceous silver-gold ores have come chiefly from four large mines of the Tonopah district, Nev., and declining output

from this camp more than offsets gains from such ores elsewhere. The bulk of the silver ores of this class are milled and cyanided at or near the mines, although a small quantity of richer ore is shipped to copper and lead smelters. The silver obtained as a by-product from copper, lead, and zinc ores is derived from refining the copper and lead bullion produced in smelting those and other ores.

WORLD'S PRODUCTION OF GOLD.

Value of gold produced in the world, 1860–1919.

[The annual production from 1860 to 1872 is obtained from statistics for 5-year periods compiled by Dr. Adolph Soetbeer. Since 1872 the estimates are those of the Bureau of the Mint. See Pl. V.]

Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.	Calendar year.	Value.
1860	$134,083,000	1876	$103,700,000	1892	$146,651,500	1908	$442,476,900
1861	122,989,000	1877	113,947,200	1893	157,494,800	1909	454,059,100
1862	122,989,000	1878	119,092,800	1894	181,175,600	1910	455,239,100
1863	122,989,000	1879	108,778,800	1895	198,763,600	1911	461,939,700
1864	122,989,000	1880	106,436,800	1896	202,251,600	1912	466,136,100
1865	122,989,000	1881	103,023,100	1897	236,083,700	1913	460,497,204
1866	129,614,000	1882	101,996,600	1898	286,879,700	1914	439,029,702
1867	129,614,000	1883	95,392,000	1899	306,724,100	1915	468,724,918
1868	129,614,000	1884	101,729,600	1900	254,576,300	1916	454,176,500
1869	129,614,000	1885	108,435,600	1901	260,992,900	1917	419,422,100
1870	129,614,000	1886	106,163,900	1902	296,737,600	1918	380,924,500
1871	115,577,000	1887	105,774,900	1903	327,702,700	1919[a]	365,166,000
1872	115,577,000	1888	110,196,900	1904	347,377,200		
1873	96,200,000	1889	123,489,200	1905	380,288,700		13,337,319,524
1874	90,750,000	1890	118,848,700	1906	402,503,000		
1875	97,500,000	1891	130,650,000	1907	412,966,600		

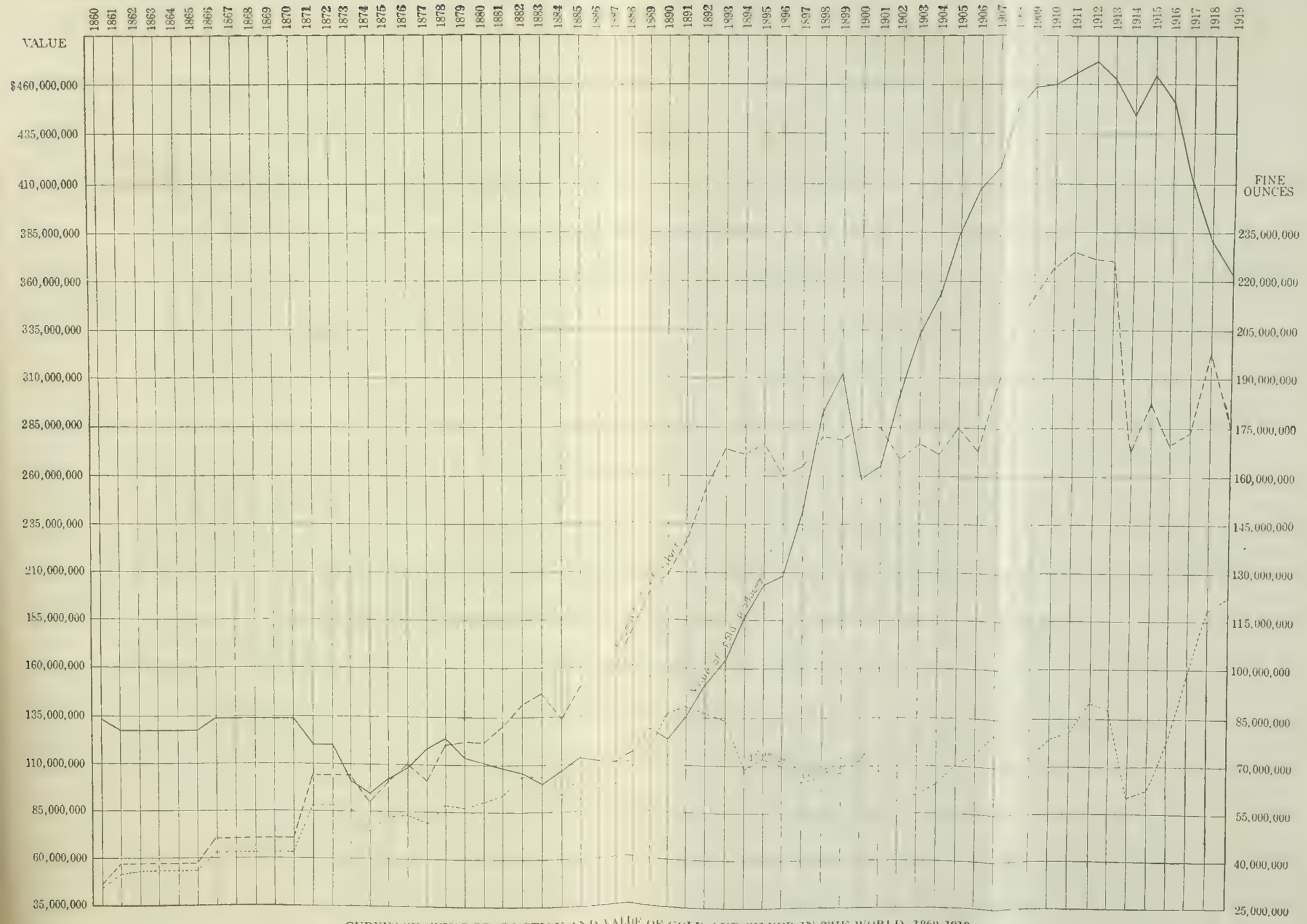
[a] Revised figures will be given in the report for 1920.

In 1919 the estimated total production of gold in the world decreased $15,758,000, following a decrease of about $38,500,000 in 1918. The production in the United States decreased about $8,300,000; Mexico, $1,576,000; Africa, $3,293,000; Australasia, $3,156,000. The production in Canada increased about $1,171,000 in 1919, and there was also a small increase in Colombia.

In the following table is shown the output of gold, by countries, as given by the Bureau of the Mint:

World's production of gold, 1913–1919.

Country.	1913	1914	1915	1916	1917	1918	1919
North America:							
United States	$88,884,400	$94,531,800	$101,035,700	$92,590,300	$83,750,700	$68,646,700	$60,333,400
Canada	16,598,900	15,983,004	18,977,901	19,235,000	15,273,000	14,687,900	15,858,800
Mexico	19,308,800	4,788,175	6,559,275	7,690,700	9,000,000	16,824,700	15,248,600
Africa	207,326,500	201,996,796	217,851,898	222,948,900	214,304,300	197,073,600	193,780,600
Australasia	53,113,200	47,569,023	48,988,177	40,475,800	34,398,100	29,268,600	26,112,200
Europe:							
Russia, Finland and Siberia	26,508,700	28,586,392	26,322,746	22,500,000	18,000,000	12,000,000	12,000,000
Austria-Hungary	2,179,300	200,744	1,392,465	1,000,000	150,000	180,000	.....
Germany	135,600	.....	.....	.....	.....	.....	.....
Sweden	17,600	54,304	25,323	12,200	10,000	10,000	10,000
Italy	17,200	32,145	2,295	2,000	700	22,800	15,000
Spain and Portugal	2,300	2,336	661	.....	.....	.....	.....
Turkey	500	475	475	.....	.....	.....	.....
France	2,127,400	1,400,000	1,400,000	1,000,000	700,000	500,000	150,900
Great Britain	17,900	20,238	19,266	5,700	5,000	.....	.....
Serbia	328,000	116,000	.....	.....	.....	.....	.....
Greece	.....	.....	.....	.....	.....	.....	500,000
Czecho-Slovakia	.....	.....	.....	.....	.....	.....	125,600



CURVES SHOWING PRODUCTION AND VALUE OF GOLD AND SILVER IN THE WORLD, 1860–1919.

World's production of gold, 1913–1919—Continued.

Country.	1913	1914	1915	1916	1917	1918	1919
South America:							
Argentina	$2,600			$15,300	$4,600	$4,000	$4,000
Bolivia and Chile	336,884	$202,770	$814,418	301,000	770,700	770,000	770,000
Colombia	2,971,700	4,678,587	5,453,148	6,173,900	5,000,000	4,866,500	6,000,000
Ecuador	406,500	346,853	545,674	560,000	887,800	800,000	800,000
Brazil	2,254,700	2,139,803	2,424,515	2,890,000	2,958,000	2,800,000	2,800,000
Venezuela	419,040	564,220	1,395,349	1,269,900	636,900	473,200	600,000
Guiana:							
British	1,353,500	1,126,500	923,892	660,700	519,000	400,000	507,400
Dutch	470,400	503,400	449,054	438,200	445,000	322,200	329,400
French	3,050,600	1,959,793	1,959,793	1,600,000	1,438,500	1,100,000	1,100,000
Peru	912,280	1,022,125	1,109,891	1,267,400	1,254,100	1,250,000	1,191,500
Uruguay	29,900	15,276	11,836	12,000	10,000	10,000	10,000
Central America	2,721,700	2,393,190	2,970,271	3,517,600	3,122,000	3,400,000	3,300,000
Asia:							
Japan	3,614,400	4,679,358	5,386,066	5,185,600	4,679,700	5,105,900	4,386,300
China	3,658,900	3,658,900	2,804,692	3,100,700	3,600,100	3,600,000	3,300,000
Indo-China	74,700	66,419	43,659	65,600	50,000	50,000	40,000
Chosen (Korea)	3,582,500	3,309,870	3,739,477	4,122,400	3,363,800	3,300,000	2,800,000
Siam	56,500						
India, British	12,178,060	11,378,400	11,522,457	11,206,500	10,812,800	10,028,000	10,486,000
East Indies, British	1,352,000	4,480,853	3,100,000	3,000,000	2,853,700	2,571,400	1,850,000
East Indies, Dutch	3,387,100						
Federated Malay States	282,400	269,147	351,527	327,900	342,400	345,300	339,000
Formosa	814,600	952,806	1,143,017	1,001,200	1,081,200	513,700	417,300
	460,497,204	439,029,702	468,724,918	454,176,500	419,422,100	380,924,500	[a]365,166,000

[a] Revised figures will be given in the report for 1920.

Estimates have been made for the years from 1914 to 1919 for some foreign countries that produce comparatively small quantities of gold, because of the difficulty of obtaining accurate statistics since the beginning of the World War. For a few other countries, because of lack of basis for estimates, the figures for preceding years have been repeated. The statistics for 1913 to 1919, inclusive, were mainly adjusted in conference between the Mint and the Geological Survey.

The notable increase of total world's output of gold culminated in a record of $468,724,918 in 1915. There has been a steady yearly decrease since 1915, and the output in 1919 was $103,559,000 less than that of 1915.

The present tendency, in the absence of discovery and development on a large scale of new gold fields, is toward a declining world's output of new gold; and this tendency is accentuated by the high cost of labor and supplies, which makes the operation of many gold mines unprofitable. There was another decrease in the world's output in 1920, although the production of Canada and some South American countries increased. These small increases, however, were more than offset by large decreases in the United States and Australia.

WORLD'S PRODUCTION OF SILVER.

The figures for the world's production of silver in 1919 show that the United States and Canada produced about 41 per cent, against 45 per cent in 1918, and that Mexico, Central America, and South America yielded nearly 46 per cent, so that approximately only 21,965,000 ounces of silver came from all other countries, mainly from Australia, Japan, Spain, and Burma. There was a small increase in the quantity of silver produced in Mexico in 1919, but the production from mines in the United States decreased about 11,128,000 ounces and that from Canada decreased 5,609,500 ounces. The total decrease in the world's production of silver in 1919 was about 22,877,500 ounces.

World's production of silver, 1913–1919, in fine ounces.

Country.	1913	1914	1915	1916	1917	1918	1919
North America:							
United States	66,801,500	72,455,100	74,961,075	74,414,800	71,740,400	67,810,100	56,682,400
Canada	31,524,708	28,406,711	26,625,960	25,459,700	22,221,300	21,284,600	15,675,100
Mexico	70,703,828	27,546,752	39,570,151	22,838,400	35,000,000	62,517,000	62,682,000
Central America	2,135,641	2,754,868	2,920,496	2,602,500	2,369,500	2,900,000	2,800,000
South America:							
Bolivia and Chile	3,932,594	789,685	3,870,065	4,402,100	4,151,600	4,335,000	4,335,000
Argentina	35,271	.....	.....	21,300	29,000	25,000	25,000
Brazil	28,364	76,685	21,523	22,000	25,000	25,000	25,000
Colombia	587,683	351,271	351,271	309,400	325,000	325,000	494,300
Ecuador	22,642	16,726	24,655	30,000	45,000	40,000	40,000
Peru	9,971,067	9,214,190	9,419,950	10,787,000	10,864,400	10,800,000	9,781,700
Guiana and Uruguay	51,111	.....	.....	8,500	8,000	8,000	8,000
Venezuela	.....	.....	.....	.....	3,300	3,000	4,100
Europe:							
Czecho-Slovakia	.....	.....	.....	.....	.....	.....	581,000
Austria-Hungary	2,104,107	1,572,746	1,772,699	1,500,000	1,500,000	1,750,000	
Germany	4,984,677	.....	.....	.....	.....	.....	.....
France	520,766	.....	.....	.....	.....	.....	12,000
Great Britain	128,543	135,458	96,450	86,500	75,000	50,000	75,000
Greece	803,750	591,464	591,464	350,000	350,000	350,000	160,000
Italy	423,888	510,365	493,856	486,500	486,500	500,000	350,000
Norway	247,988	440,917	413,867	439,100	294,900	270,200	270,200
Spain and Portugal	4,437,637	4,434,417	4,567,454	4,517,800	2,850,000	3,100,000	2,900,000
Russia	.....	.....	638,403	550,000	500,000	400,000	400,000
Serbia	28,758	12,014	.....	10,000	20,000	20,000	20,000
Sweden	58,969	33,511	24,230	37,900	35,000	31,500	31,500
Turkey	1,509,133	1,509,133	1,509,133	500,000	400,000	400,000	100,000
Australasia	18,128,577	11,000,000	9,250,000	10,700,000	10,000,000	10,000,000	7,430,800
Asia:							
British India	.....	236,440	284,875	280,000	275,000	270,000	192,600
China	.....	.....	18,230	30,000	63,900	70,000	65,000
Chosen (Korea)	15,048	16,864	21,897	25,000	26,500	26,000	20,000
Dutch East Indies	465,980	400,000	400,000	400,000	400,000	400,000	1,286,000
Indo-China	.....	1,767	1,056	1,000	1,000	1,000	1,000
Formosa	51,763	51,080	47,653	47,700	39,600	26,900	25,000
Japan	4,649,910	4,836,228	5,120,293	5,805,700	7,111,700	6,600,400	4,800,000
Burma	.....	.....	.....	977,100	1,793,700	1,970,500	1,973,000
Africa:							
Algeria	.....	.....	.....	.....	.....	.....	170,800
Belgian Kongo	1,454	4,770	4,770	11,000	10,300	10,500	10,000
Egypt	.....	1,223	1,657	1,200	900	800	300
French East Africa							
Madagascar	.....	.....	.....	20,000	20,000	20,000	17,700
Rhodesia	121,537	150,794	185,233	200,700	212,000	175,700	180,600
Transvaal, Cape Colony, Natal	933,191	901,763	996,379	968,900	938,100	877,500	891,300
Portuguese East Africa	.....	.....	.....	1,200	1,200	1,200	1,000
	225,410,085	168,452,942	184,204,745	168,843,000	174,187,800	197,394,900	[a]174,517,400

[a] Estimates for 1919 will be revised in the report for 1920.

World's production of silver, 1860–1919.

[The annual production from 1860 to 1872 is obtained from statistics for 5-year periods compiled by Dr. Adolph Soetbeer. For the period since 1872 the estimates are those of the Bureau of the Mint. See PL. V.]

Year.	Quantity (fine ounces).	Commercial value.	Year.	Quantity (fine ounces).	Commercial value.
1860	29,095,428	$39,337,000	1891	137,170,000	$135,500,200
1861	35,401,972	46,191,000	1892	153,151,762	133,404,400
1862	35,401,972	47,651,000	1893	165,472,621	129,119,900
1863	35,401,972	47,616,000	1894	164,610,394	104,493,000
1864	35,401,972	47,616,000	1895	167,500,960	109,545,600
1865	35,401,972	47,368,000	1896	157,061,370	105,859,300
1866	43,051,583	57,646,000	1897	160,421,082	96,252,700
1867	43,051,583	57,173,000	1898	169,055,253	99,742,600
1868	43,051,583	57,086,000	1899	168,337,452	101,002,600
1869	43,051,583	57,043,000	1900	173,591,364	107,626,400
1870	43,051,583	57,173,000	1901	173,011,283	103,806,700
1871	63,317,014	83,958,000	1902	162,763,483	86,264,700
1872	63,317,014	83,705,000	1903	167,689,322	90,552,200
1873	63,267,187	82,120,800	1904	164,195,266	95,233,300
1874	55,300,781	70,674,400	1905	172,317,688	105,113,700
1875	62,261,719	77,578,100	1906	165,054,497	111,721,100
1876	67,753,125	78,322,600	1907	184,206,984	121,577,100
1877	62,679,916	75,278,600	1908	203,131,404	108,655,100
1878	73,385,451	84,540,000	1909	212,149,023	110,364,400
1879	74,383,495	83,532,700	1910	221,715,673	119,727,000
1880	74,795,273	85,640,600	1911	226,192,923	122,143,800
1881	79,020,872	89,925,700	1912	224,310,654	137,883,800
1882	86,472,091	98,232,300	1913	225,410,085	136,153,700
1883	89,175,023	98,984,300	1914	168,452,942	93,174,700
1884	81,567,801	90,785,000	1915	184,204,745	95,587,500
1885	91,609,959	97,518,800	1916	168,843,000	115,905,600
1886	93,297,290	92,793,500	1917	174,187,800	155,941,600
1887	96,123,586	94,031,000	1918	197,394,900	194,327,400
1888	108,827,606	102,185,900	1919	174,517,400	195,611,300
1889	120,213,611	112,414,100			
1890	126,095,062	131,937,000		7,240,348,409	5,798,349,800

Most of the world's output of silver is produced or refined in the United States, but a large part of it is consumed in Great Britain, India, and China, and the price of silver has been dominated by the London market. "Silver, its romance and history," by Benjamin White, contains information relating to the buying and selling of silver and the fixing of the market quotations, which was quoted in the chapter on gold and silver in Mineral Resources for 1918.

MINES REPORT.

METHOD OF COLLECTING STATISTICS.

The first table below presents the final official figures of the production of gold and silver in the United States in 1919 as agreed upon by the Bureau of the Mint and the United States Geological Survey. With the comparatively unimportant exceptions of domestic gold and silver contained in ores and mattes exported for reduction during the year, these figures record the actual production of gold and silver bullion from domestic ores in marketable form as metals, either refined or unrefined.

Owing to the difficulty of tracing this total gold and silver produced back to its source by States, counties, and mining districts, however, the Geological Survey attacks this problem of distribution by systematic investigation of the "mine production" of ores containing gold and silver during the calendar year and of the output of the placer mines. In this way the state of the mining industry is studied

in detail, and the output is classified by methods of production and by kinds of ore, as well as by mining districts. The resulting figures form the basis of the mines reports.

Of the two plans for ascertaining the gold and silver production of the United States one is a measure of the mining industry and the other a measure of the metallurgic industry; one reports the mine output and its recoverable content and the other the metal actually recovered in marketable form. The two methods will not produce exactly corresponding results, nor should they be expected to do so, but the figures for a period of years sufficiently long to compensate for overlap or lag should agree within allowable limits of error due to the complexity of the problem involved. For the last 15 years in which complete statistics have been gathered by both methods the final figures have been as follows:

Gold and silver produced in the United States, 1905–1919, according to mint and to mine returns.

Year.	Mint.		Mine.	
	Gold.	Silver.	Gold.	Silver.
		Ounces.		*Ounces.*
1905	$88,180,700	56,101,600	$88,159,881	56,272,496
1906	94,373,800	56,517,900	97,219,645	57,362,455
1907	90,435,700	56,514,700	87,471,136	52,500,104
1908	94,560,000	52,440,800	91,914,891	50,878,140
1909	99,673,400	54,721,500	99,438,144	57,315,677
1910	96,269,100	57,137,900	94,933,778	57,598,509
1911	96,890,000	60,399,400	97,054,791	61,108,791
1912	93,451,500	63,766,800	92,880,467	66,041,506
1913	88,884,400	66,801,500	89,987,888	71,200,237
1914	94,531,800	72,455,100	92,703,757	69,633,769
1915	101,035,700	74,961,075	99,605,314	72,368,878
1916	92,590,300	74,414,802	92,822,430	78,875,176
1917	83,750,700	71,740,362	82,032,745	70,665,531
1918	68,646,700	67,810,139	67,701,936	68,063,090
1919	60,333,400	56,682,445	58,225,112	51,907,869
	1,343,607,200	942,466,023	1,332,151,915	941,792,228

These figures show, according to the reports of the Mint, a total excess of gold for the 15 years of $11,455,285, or a difference of less than 1 per cent, and a total excess of silver of only 673,795 ounces, or a difference of about 0.07 per cent. The figures for Alaska placers are not considered to be so closely approximate as the total figures for gold, hence the differences for the United States proper are probably even lower. It is thought that those small differences are fully accounted for in the detailed discussions of the subject in previous reports of this series. For any one year an excess of mining over smelting and refining is indicated by larger returns in the mines reports for gold or silver, or both, and an excess of smelting and refining and drawing upon stocks are indicated by larger returns in the report of the Mint.

UNITS OF MEASUREMENT.

In the measurement of ores and concentrates the short ton of 2,000 pounds is used throughout. The price of gold is fixed by law at $20.67+ per fine ounce. The annual average prices for silver from 1865 to 1915, based on the equivalent New York value of a fine ounce with exchange at par, are given elsewhere in this report. (See p. 667.)

The average prices for silver in 1916, 1917, and 1919 are based on the dealers' buying price at New York, and the average price for silver in 1918, used in computing the mine output, was that given by the Bureau of the Mint as the approximate actual selling price of all silver sold. The average commercial prices (or dealers' prices) for silver 0.999 fine at New York are those quoted from day to day on the market and run uniformly somewhat below the prices as given elsewhere by years.

PRODUCTION OF GOLD AND SILVER REPORTED FROM THE MINES.

The following table gives the quantity and value of the output of recoverable gold and silver ("mine production") by States reported from the producing mines in 1919 to the United States Geological Survey. The increase or decrease of production shows results by comparison with the corresponding Geological Survey mine figures for 1918.

Mine production of gold and silver in the United States in 1919.

State or Territory.	Gold.		Silver.		Increase or decrease.	
	Quantity (fine ounces).	Value.	Quantity (fine ounces).	Value.	Gold.	Silver (fine ounces).
Alabama					− $797	− 2
Alaska	455,984.30	$9,426,032	629,708	$705,273	− 54,920	− 218,081
Arizona	217,997.72	4,506,413	5,266,605	5,898,598	− 928,614	− 1,419,547
California	807,666.82	16,695,955	1,107,189	1,240,051	+ 167,002	− 320,522
Colorado	478,265.58	9,886,627	5,758,010	6,448,971	−2,865,091	− 1,305,544
Georgia	37.10	767	8	9	− 5,126	− 17
Idaho	34,502.89	713,238	5,579,056	6,248,543	+ 10,422	− 3,593,284
Illinois			4,440	4,973		− 3,731
Maine, New Hampshire, New York, and Vermont	25.25	522	6,356	7,119	− 243	− 4,751
Michigan			441,430	494,402		− 68,037
Missouri			90,401	101,249		+ 43,462
Montana	107,856.32	2,229,588	12,541,181	14,046,123	− 875,176	− 4,256,298
Nevada	219,695.16	4,541,502	6,863,580	7,687,210	−2,078,435	− 3,137,019
New Mexico	31,717.36	655,656	837,418	937,908	− 27,135	+ 54,997
North Carolina	.97	20	19	21	− 1,611	+ 2
Oregon	47,303.25	977,845	111,121	124,455	− 292,620	+ 3,798
Philippine Islands	63,357.79	1,309,722	8,409	9,418	+ 19,722	+ 4,271
Porto Rico					− 100	
South Carolina	3.92	81	19	21	+ 81	+ 19
South Dakota	235,249.57	4,863,040	116,493	130,472	−1,702,297	− 42,709
Tennessee	273.90	5,662	98,288	110,083	+ 796	+ 4,668
Texas	1.21	25	538,642	603,279		− 37,923
Utah	104,464.41	2,159,471	11,649,961	13,047,956	− 789,699	− 1,805,636
Virginia					− 400	− 1,814
Washington	12,232.20	252,862	259,384	290,510	− 51,796	− 50,709
Wyoming	4.06	84	151	169	− 787	− 814
	2,816,639.78	58,225,112	51,907,869	58,136,813		−16,155,221
Decrease in value					−9,476,824	−$9,926,277

A decrease in production of gold from mines of the United States of $9,476,824 is shown for 1919, following a decrease of $14,330,809 in 1918 and of $10,789,685 in 1917. A decrease of 16,155,221 ounces of silver is shown, following a decrease of 2,602,441 ounces in 1918.

The principal gold-producing States in 1919 were California, Colorado, Alaska, South Dakota, Nevada, and Arizona, and these six States together made about 86 per cent of the total output. The only notable increase in gold was in California, which produced about $167,002 more in 1919 than in 1918. The most notable decreases in gold were $2,865,091 in Colorado, $928,614 in Arizona, $2,078,435 in

Nevada, $1,702,297 in South Dakota, $789,699 in Utah, and $875,176 in Montana. Every State that yielded more than $1,000 in gold except California, Idaho, Philippine Islands, and Tennessee had a decreased output in 1919.

The principal silver-producing States in 1919 were Montana, Utah, Nevada, Colorado, Idaho, and Arizona, and these six States together produced more than 91 per cent of the total for the United States. The only comparatively large increases in 1919 were in New Mexico and Missouri, and only seven States had an increased output. There were decreases of 3,137,019 ounces in Nevada, 3,593,284 ounces in Idaho, 4,256,298 ounces in Montana, 320,522 ounces in California, 1,305,544 ounces in Colorado, 1,419,547 ounces in Arizona, and 1,805,636 ounces in Utah.

About $30,925,000, or more than 52 per cent of the entire output of gold in the United States in 1919, was produced by 25 companies, none of which yielded less than $500,000. The largest producer was the celebrated Homestake mine in South Dakota. Nineteen of the larger properties produced gold from dry or siliceous ores, three produced it from gravels by dredging, and three recovered the gold in the treatment of copper ores. Nine of the largest producers of gold in 1919 were in California, and six in Colorado. The decrease in Nevada is shown by the absence of the Goldfield Consolidated and other famous Nevada mines from the list.

Larger producers of gold in the United States in 1919, in order of output.

Rank.	Operator.	State.	Mining district.	Source of gold.
1	Homestake Mining Co.	South Dakota	Whitewood	Dry or siliceous ores.
2	Yuba Consolidated Goldfields	California	Marysville	Dredging gravels.
3	United Eastern Mining Co.	Arizona	Oatman	Dry or siliceous ores.
4	Chichagoff Mining Co.	Alaska	Sitka	Do.
5	Natomas Co. of California	California	Oroville and Folsom.	Dredging gravels.
6	Portland Gold Mining Co.	Colorado	Cripple Creek	Dry or siliceous ores.
7	Empire Mines	California	Grass Valley	Do.
8	Cresson Consolidated Mining Co.	Colorado	Cripple Creek	Do.
9	Alaska Gastineau Mining Co.	Alaska	Juneau	Do.
10	North Star Mines	California	Grass Valley	Do.
11	Vindicator Consolidated Gold Mining Co.	Colorado	Cripple Creek	Do.
12	Carson Hill Gold Mines	California	Mother Lode	Do.
13	Argonaut Mining Co.	do	Grass Valley	Do.
14	Liberty Bell Gold Mining Co.	Colorado	Upper San Miguel.	Do.
15	Plymouth Consolidated Mining Co.	California	Mother Lode	Do.
16	Tomboy Gold Mines Co.	Colorado	Upper San Miguel.	Do.
17	Tom Reed Gold Mines Co.	Arizona	Oatman	Do.
18	Barnes King Mining Co.	Montana	Ottawa	Do.
19	Anaconda Copper Mining Co.	do	Summit Valley	Copper ores.
20	Marysville Dredge Co.	California	Marysville	Dredging gravels.
21	Utah Copper Co.	Utah	West Mountain	Copper ores.
22	Calumet & Arizona Mining Co.	Arizona	Turquoise	Do.
23	Smuggler Union Mining Co.	Colorado	Upper San Miguel.	Dry or siliceous ores.
24	Kennedy Mining & Milling Co.	California	Mother Lode	Do.
25	Alaska Juneau Mining Co.	Alaska	Juneau	Do.

Exclusive of the output of gold of the large producing operators, about $27,300,000 came from the operation of more than 3,500 placer and deep mines, many of which produced between $100,000 and $400,000 each. Hundreds of mines, especially placer properties in California, Oregon, Idaho, Alaska, Arizona, and the Appalachian States, yielded very small quantities of gold, and the average production of the smaller mines was less than $5,000.

The largest output of silver was that of the Anaconda Copper Mining Co. Six of the 25 mines enumerated in the subjoined list recovered silver from copper ore, 11 from lead ore, 6 from dry or siliceous ore, and 2 from zinc-lead ore. The Presidio mine in Texas was the largest producer of silver from ore that contained no appreciable quantity of any other metal. The approximate output of the 25 properties was 25,020,000 ounces, or slightly less than half of the total production of silver in the United States in 1919, as against 53 per cent in 1918. Six of the largest producers were in Utah, five each in Montana and Idaho, and four in Nevada.

Larger producers of silver in the United States in 1919, in order of output.

Rank.	Operator.	State.	Mining district.	Source of silver.
1	Anaconda Copper Mining Co.	Montana	Summit Valley	Copper ores.
2	Chief Consolidated Mining Co.	Utah	Tintic	Lead ores.
3	Tintic Standard Mining Co.	do.	do.	Do.
4	Butte & Superior Mining Co.	Montana	Summit Valley	Lead-zinc ores.
5	Bunker Hill & Sullivan Mining Co.	Idaho	Yreka	Lead ores.
6	Smuggler Union Mining Co.	Colorado	Sneffels and Upper San Miguel.	Siliceous ores.
7	Calumet & Arizona Mining Co.	Arizona	Warren	Copper ores.
8	Tonopah Extension Mining Co.	Nevada	Tonopah	Dry or siliceous ores.
9	Tonopah-Belmont Development Co.	do.	do.	Do.
10	Hecla Mining Co.	Idaho	Leland	Lead ores.
11	North Butte Mining Co.	Montana	Summit Valley	Copper ores.
12	United Verde Copper Co.	Arizona	Verde	Do.
13	Elm Orlu Mining Co.	Montana	Summit Valley	Lead zinc ores.
14	Tonopah Mining Co.	Nevada	Tonopah	Dry or siliceous ores.
15	Davis Daly Copper Co.	Montana	Summit Valley	Copper ores.
16	Federal Mining & Smelting Co.	Idaho	Hunter	Lead ores.
17	Presidio Mining Co.	Texas	Shafter	Siliceous (silver) ores.
18	Hercules Mining Co.	Idaho	Leland	Lead ores.
19	West End Consolidated Mining Co.	Nevada	Tonopah	Dry or siliceous ores.
20	Silver King Coalition Mining Co.	Utah	Uintah	Lead ores.
21	Caledonia Mining Co.	Idaho	Yreka	Do.
22	Ontario Silver Mining Co.	Utah	Uintah	Do.
23	Iron Blossom Consolidated Mining Co.	do.	Tintic	Do.
24	Copper Queen Consolidated Mining Co.	Arizona	Warren	Copper ores.
25	United States Mining Co.	Utah	West Mountain	Lead ores.

MINE PRODUCTION OF GOLD AND SILVER, BY STATES.

ALASKA.

It is estimated that the total production of gold in Alaska from the earliest mining, in 1880, to the end of 1919 has been $311,664,993, of which $218,012,992 has come from placers. The total production of silver has been 9,019,016 fine ounces, of which 5,815,886 ounces was recovered from copper ores and 1,774,550 ounces from the refining of placer gold.[3]

Gold.—The mine production of gold in Alaska in 1919 was $9,426,032, or about $54,920 less than that of 1918. The yield from siliceous ores increased from $3,473,317 in 1918 to $4,392,237 in 1919; the yield from copper ores decreased from $107,635 in 1918 to $63,795 in 1919; the placer output in 1919 was $4,970,000 against $5,900,000 in 1918. Twenty-eight dredges produced $1,360,000 of the placer gold, which was $65,000 less than the yield from dredging in 1918.

[3] U. S. Geol. Survey Mineral Resources, 1919, pt. 1, pp. 227–233, 1921.

Of the productive gold lode mines, 7 were in southeastern Alaska, 1 on Prince William Sound, 3 in Kenai Peninsula, 5 in Willow Creek district, and 6 in Fairbanks district, and 1 on Seward Peninsula. The 7 deep gold mines in southeastern Alaska yielded more than 95 per cent of the gold derived from siliceous ores.

The 3,262,573 tons of siliceous ores treated in 1919 yielded an average of $1.38 in gold and silver a ton, and the 492,644 tons of copper ore contained $1.24 in gold and silver a ton and had a copper content of 4.8 per cent.

About 47 per cent of the total output of gold in Alaska came from gold lode mines in 1919, against 37 per cent in 1918, 31 per cent in 1917, and 29 per cent in 1912. The 554 placers operated in 1919 yielded approximately 4,548,000 cubic yards of auriferous gravel, of which the dredges handled about 1,760,000 cubic yards and made an average recovery of 77 cents a cubic yard in 1919, against 57 cents a yard in 1918, 68 cents a yard in 1917, 69 cents a yard in 1916, 51 cents a yard in 1915, and 53 cents a yard in 1914.

The estimated total recovery of gold by dredging for the period 1903–1919, inclusive, is $20,395,000.

No important new placer-bearing areas were reported in 1919.

Silver.—The mine production of silver in Alaska in 1919 was 629,708 fine ounces, against 847,789 ounces in 1918. The copper mines produced 488,034 ounces—a decrease of 231,357 ounces; the siliceous ores yielded 108,691 ounces in 1919, against 90,064 ounces in 1918; and the placers yielded 32,983 ounces in 1919, against 38,334 ounces in 1918.

ARIZONA.

Gold.—The mine production of gold in Arizona in 1919 was $4,506,413, which was $928,614 less than in 1918. Placers contributed only $4,694, which came from small mines in Yuma, Cochise, Maricopa, and Yavapai counties. The deep mines produced $4,501,719, of which 62 per cent came from dry or siliceous ores mined chiefly in Mohave, Yavapai, and Cochise counties; and 36 per cent was contained in copper ores mined chiefly in Cochise and Yavapai counties. Mohave County had a gold output of $2,582,331, a decrease of $216,572, Cochise County produced $940,538, and Yavapai County $614,968. The gold recovered from ores treated at gold and silver mills represented about 57 per cent of the total output, against 53 per cent in 1918, and crude ores shipped to smelters contained nearly 35 per cent. The crude copper ores mined and smelted directly (without previous concentration) contained an average gold content of 58 cents a ton.

Silver.—The mine production of silver in Arizona decreased from 6,686,152 fine ounces in 1918 to 5,266,605 ounces in 1919. Of this production 3,711,052 ounces came from copper ores, 1,031,185 ounces from dry or siliceous ores, 441,739 ounces from lead ores, and 82,593 ounces from copper-lead ores. Cochise County produced 2,421,905 ounces in 1919, of which 1,593,094 ounces came from copper ores and 626,645 ounces from siliceous ores. The silver output of Yavapai County, which decreased from 2,502,968 ounces in 1918 to 1,252,894 ounces in 1919, was mainly derived from copper ores. Bullion recovered from gold and silver ores, almost all by cyanidation,

yielded 117,641 ounces of silver. Concentrates contained 1,085,082 ounces, and crude ore shipped to smelters contained 3,971,687 ounces.

CALIFORNIA.

Gold.—The mine production of gold in California in 1919 was $16,695,955. The increase of $167,002 was mainly due to a larger production from placer operations.

In 1919 the deep mines produced $8,662,879 (a decrease of $27,295), of which gold-quartz ores yielded 98 per cent and copper ores 1.5 per cent. California placers in 1919 produced $8,033,076 in gold, or $194,297 more than in 1918. Of the placer production, $7,716,919 was recovered by dredging. The total dredge production from 1896 to the end of 1919 has been $110,335,831, and the yield of gold by dredges was equal to 46 per cent of the total yield of gold for 1919. The Yuba County dredges, 12 in number, made the largest output of gold, the value being $4,185,926, an increase of $435,893. Sacramento County, with 10 dredges working, made an output of $1,712,705 an increase of $22,426. In Butte County (including Oroville and other districts) 6 dredges produced $361,604 in gold, or $264,406 less than in 1918. Dredges were also operated in Calaveras, Amador, Merced, Stanislaus, Placer, Shasta, Siskiyou, San Joaquin, and Trinity counties

Five of the 32 counties in California which reported mine production of gold each had a yield of more than $1,000,000 in 1919, as follows: Nevada, $2,981,312; Amador, $2,920,492; Yuba, $4,195,732; Sacramento, $1,714,193; Calaveras, $1,550,574. Of these Yuba and Sacramento counties obtained most of their gold by dredging, Amador and Calaveras are on the Mother Lode, and Nevada County produced mainly from siliceous ores of the Grass Valley district. The five Mother Lode counties—Amador, Calaveras, Eldorado, Mariposa, and Tuolumne—whose output is mainly gold milling ores, produced $3,321,121 in gold from mill bullion and $1,515,317 from concentrates in 1919, against a recovery of $2,657,624 from mill bullion and $1,614,455 from concentrates in 1918.

Silver.—The mine production of silver in California in 1919 was 1,107,189 fine ounces—a decrease of 320,522 ounces. About 32 per cent of the output, or 349,480 ounces, came from the copper ores. Siliceous ores yielded 547,541 ounces, silver-lead ores, zinc ores, and lead ores 182,244 ounces, and placers the remainder. The only counties producing more than 100,000 ounces of silver in 1919 were Shasta, San Bernardino, Plumas, and Inyo. About 63 per cent of all the silver was recovered from crude ores sent to smelters.

COLORADO.

Gold.—The total mine production of gold in Colorado in 1919 was $9,886,627, a decrease of $2,865,091, following a decrease of $3,424,597 in 1917 and of $2,977,506 in 1918. The Cripple Creek district, with a decrease of $2,291,931, produced $5,827,816 in gold, which was 59 per cent of the State output of gold from all sources.

The San Juan region, in Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $2,338,871; Lake County yielded $625,956, a decrease of $217,283. Siliceous and dry ores, which

amounted to 87 per cent of all the ore sold or treated, yielded 90 per cent of the total output of gold. Slightly more than 2 per cent came from lead ore, nearly 6 per cent from placers, and the remainder from other classes of ore. The placer production in 1919 was $550,562, an increase of $24,360. Summit County produced 84 per cent and Lake County nearly 15 per cent of the placer gold. Dredges in these two counties recovered more than 98 per cent of the placer gold.

Silver.—The mine production of silver in Colorado in 1919 was 5,758,010 fine ounces, a decrease of 1,305,544 ounces. Lake County, principally Leadville, produced 1,542,324 ounces, a decrease of 747,797 ounces. San Miguel County produced 1,100,942 ounces, an increase of 264,372 ounces. Siliceous and dry ores yielded 73.5 per cent of the silver recovered, lead ores 18.55 per cent, lead-zinc ores 5 per cent, and copper ores less than 2 per cent. The remainder came from placers, zinc ores, and copper-lead ores.

IDAHO.

Gold.—The mine production of gold in Idaho in 1919 was $713,238, an increase of $10,422. The total production of gold from Idaho from the discovery of placer gold in 1863 to the end of 1919 is estimated at $132,327,023 by C. N. Gerry.[4]

Boise and Shoshone counties were the largest producers of gold in 1919 and yielded about 84 per cent of the total output. The lode mines produced gold valued at $522,486. The placer mines produced $190,752 in gold in 1919, of which $164,854 was won by dredging. The total output of gold recovered by dredges from 1897 to the end of 1919 has been $4,186,119. Of the total gold in 1919 about 27 per cent came from placers, 65 per cent from siliceous ores, 3 per cent from copper ores, and the remainder from lead and lead-zinc ores.

Silver.—The mine production of silver in Idaho in 1919 was 5,579,056 fine ounces, or 3,593,284 ounces less than in 1918. The total yield of silver from Idaho for the period 1863 to 1919, inclusive, is 239,457,351 fine ounces.[5]

There was a decrease of 43 per cent in the output of silver from Shoshone County, which yielded 86 per cent of the total quantity of silver in 1919, 92 per cent in 1918, 93.4 per cent in 1917, 95 per cent in 1916 and 1915, and 98 per cent in 1914. Lead ores contained 85 per cent of the output of silver and lead-zinc ores 8.8 per cent. Crude ore shipped, which averaged 20.14 ounces of silver a ton, supplied nearly 29 per cent of the silver, and concentrates, which averaged 20.18 ounces of silver a ton, contained more than 71 per cent of the total silver. The decreased quantity of lead and copper ores mined had the effect of curtailing the production of silver.

MAINE AND VERMONT.

A small quantity of gold and about 6,356 ounces of silver were obtained from copper ores and old slag shipped from the Pike Hill, Ely, and Elizabeth mines in Vermont and the Douglas mine at Blue Hill, in Maine.

[4] U. S. Geol. Survey Mineral Resources, 1919, pt. 1, p. 451.
[5] Op. cit., p. 451.

MICHIGAN.

Silver.—The copper mines of Michigan produced 441,430 fine ounces of silver in 1919, against 509,467 fine ounces in 1918. The silver was derived mainly from the electrolytic treatment of 29,583,000 pounds of copper. The average recovery of silver per ton of "rock" treated was 0.27 ounce. Of the total output of silver 393,642 ounces came from mines in Houghton County.

MISSOURI, OKLAHOMA, ILLINOIS, AND KENTUCKY.

Silver.—The lead and zinc mines of the Central States produce no gold and only a comparatively small quantity of silver. Nearly all the silver is a by-product from the refining of lead from concentrates of lead ores mined in southeastern Missouri. The total yield of silver from Missouri in 1919 was 90,401 fine ounces, which, with the exception of 29,480 ounces recovered from cobalt-nickel-copper ore and copper concentrates, was derived from lead recovered from 81,000 tons of galena concentrates. The average recovery was slightly more than 0.75 ounce of silver per ton of concentrate smelted.

The lead-zinc fluorspar deposits of the Kentucky-Illinois field carry silver, and from the lead concentrates shipped from Illinois in 1919 a recovery of 4,440 ounces of silver was recorded, against 8,171 ounces in 1918. The average silver content per ton recovered from lead concentrates from Illinois in 1919 was 6.16 ounces. No silver ore was shipped from the Criswell mine, near Byars, McClain County, Okla., in 1919.

MONTANA.

Gold.—The mine production of gold in Montana decreased from $3,104,764 in 1918 to $2,229,588 in 1919. The placer yield was $291,430—a decrease of $104,802. Silver Bow County had the largest total output—$579,638. Most of the placer gold was recovered by one company, which operated three dredges in Alder Gulch, in Madison County. Lewis and Clark County produced $498,703, and Deer Lodge County $289,980, chiefly from siliceous ores. At amalgamation and cyanidation plants $730,683 in gold was produced, or an average recovery of $6.59 per ton of ore and tailings treated. Ore treated at concentration mills yielded concentrates containing $525,960, or 46 cents a ton, and crude ore shipped to smelters contained $654,317 in gold, or an average of $2.19 a ton.

Silver.—Montana mines produced 12,541,181 fine ounces of silver in 1919, a production 25 per cent less than in 1918. The copper ores yielded 6,341,825 ounces (an average of 2.06 ounces per ton), of which Silver Bow County (Butte) supplied 6,327,108 ounces. The lead-zinc ores produced 3,678,353 ounces, of which Silver Bow County supplied 3,506,048 ounces. The dry or siliceous ores produced 1,707,053 ounces, of which Granite County supplied 576,183 ounces and Silver Bow County 691,863 ounces.

NEVADA.

Gold.—The mine production of gold in Nevada in 1919 was $4,541,502, against $6,619,937 in 1918. The production in 1919 from mines in Esmeralda County was $787,579—a decrease of nearly

$574,000. The Goldfield district yielded $740,265 in gold in 1919, against $1,212,572 in 1918. Nye County produced $1,537,980, of which Tonopah yielded $771,804—a decrease in Tonopah of nearly $516,000. The counties having a substantial increase in gold were Elko, Churchill, and Lyon. Forty-seven per cent of the decrease in the output of gold was due to diminished yield from Goldfield and Tonopah.

Silver.—There was a decrease in the mine production of silver in Nevada in 1919, the total being 6,863,580 fine ounces, against 10,000,599 ounces in 1918. Nye County (almost wholly from the Tonopah district) again led in output with 3,622,680 ounces, which was about 2,482,000 ounces less than in 1918. Pershing County, with 706,700 ounces, Churchill County, with 488,000 ounces, and Lincoln County, with 457,000 ounces, were the other counties which had an output exceeding 400,000 ounces. Dry or siliceous ores yielded all but 556,997 ounces of the output of silver, and 88 per cent of this yield was recovered by cyanidation.

NEW MEXICO.

Gold.—The mine production of gold in New Mexico in 1919 was $655,656, against $682,791 in 1918. The Mogollon district, Socorro County, produced $148,136; Grant County, $243,391; and Colfax and Lincoln counties, $253,687.

Copper ores, chiefly from Grant County, contained $233,489, and dry and siliceous ores yielded $407,691. The output from other kinds of ore was very small and the placer output was only $4,959.

Silver.—The mine production of silver in New Mexico decreased from 1,394,365 fine ounces in 1917 to 782,421 ounces in 1918 and to 837,418 ounces in 1919. Socorro County produced 412,917 fine ounces, chiefly from siliceous ores from the Mogollon district, the remainder from the mixed ores of the Magdalena district. The output of silver from Grant County decreased from 338,833 ounces in 1918 to 336,499 ounces in 1919, and most of this yield came from the Lordsburg and Central districts. Dry and siliceous gold and silver ores, chiefly from Grant and Socorro counties, yielded 65 per cent of the total; copper ores, chiefly from Grant County, yielded 28 per cent. The remainder of the production was from lead and copper-lead ores, mainly from the Central, Cooks Peak, Lake City, Victorio, and Magdalena districts.

OREGON.

Gold.—The mine production of gold from Oregon decreased about 23 per cent, being $977,845 in 1919 against $1,270,465 in 1918. The placer mines yielded only $380,651, or $117,598 less in 1919 than in 1918. Sixty-six per cent of the output from deep mines was from siliceous ores. The deep mines of the State produced $597,194, a decrease of $175,022. The two dredges in Baker County and one dredge in Grant County produced $296,750, and a few drift mines, hydraulic, and surface placers in Baker, Jackson, Douglas, Crook, Josephine, Wheeler, and Malheur counties produced the remainder of the placer gold. Baker County, with a yield of $837,163, was the only county that produced more than $100,000 in gold.

Silver.—The mine production of silver in Oregon in 1919 was 111,121 fine ounces—an increase of 3,798 ounces. Of the total production 89,297 ounces came from siliceous ores, 18,154 ounces from copper ores, and 3,670 ounces from placer bullion.

SOUTH DAKOTA.

The total value of the production of gold in South Dakota from 1876 to the end of 1919 is given by Charles W. Henderson, of the United States Geological Survey, as $218,947,199 and the total output of silver for the same period as 6,710,198 fine ounces.

Gold.—The mine production of gold in South Dakota in 1919 was $4,863,040, against $6,565,337 in 1918. The output was almost wholly from siliceous milling ores of low grade, of which more than 63 per cent was recovered by amalgamation and the remainder by cyanidation. The Homestake mines and mills produced $4,346,116 in bullion from 1,192,588 tons of ore treated.

Production at the Homestake during the first nine months was below normal owing to the continued shortage of labor. On September 25, 1919, a fire started in No. 3 northwest drawhole stope on the 800-foot level and it was necessary to flood the mine so that mines and mills were closed down from October 6 to December 9, during which period the water filled the mine to 78 feet above the sill of the 600-foot level. On December 9, 1919, the Pocahontas mill of 160 stamps and the Monroe mill of 100 stamps were started crushing ore mined on the surface and on the 300, 400, and 500 foot levels through the Old Brig shaft, all the other shafts being used to unwater the mine. The Mogul mill was operated on Ofer mine ore only until September 30, 1919, when all operations ceased. The small yield of placer gold (19 ounces) came from Lawrence County.

Silver.—The mine output of silver, derived mainly from refining the gold bullion produced, was 116,493 fine ounces, or 42,709 ounces less than in 1918.

SOUTHERN APPALACHIAN STATES.

The total production of gold from 1799 to the end of 1919 in the southern Appalachian States, as shown from data compiled by the Bureau of the Mint and the United States Geological Survey, has been $51,027,461. The figures credit Alabama with $766,336, Georgia with $17,824,536, North Carolina with $23,628,433, Tennessee with $258,672, Virginia with $3,296,569, South Carolina with $5,181,510, and Maryland with $71,405.

Gold.—The combined mine production of gold in the southern Appalachian States in 1919 was $6,530, against $13,587 in 1918. Tennessee led with $5,662; Georgia was next with $767. The gold produced in Tennessee was from copper ores of the Ducktown district. The production of gold from placers amounted to 34.59 ounces. Copper ores, mainly from Tennessee, yielded about 294 ounces of gold, and siliceous ores from South Carolina and Georgia yielded only about 5 ounces in 1919.

Silver.—Copper ores in Tennessee, North Carolina, and South Carolina yielded 98,324 ounces of silver in 1919 and siliceous ores and placer bullion only 10 ounces.

TEXAS.

The total output of gold from Texas mines from 1885 to the end of 1919 is given by Charles W. Henderson as $43,607,[7] and the output of silver for the same period has been 14,782,333 ounces.

The annual yield of gold has been very small, has been mainly a by-product, and in 1919 was only $25.

The mine production of silver from Texas in 1919 was 538,642 fine ounces, against 576,565 ounces in 1918. The greater part of the silver continued to come from the Presidio silver mine and cyanidation mill in the Shafter district, Presidio County. The silver contained in copper ores shipped in 1919 amounted to 25 ounces and that in lead ores to 2,395 ounces.

UTAH.

Gold.—The total output of gold in Utah from 1864 to 1919, inclusive, is given by V. C. Heikes, of the United States Geological Survey, as $98,227,974.[8]

The mine production of gold decreased from $2,949,170 in 1918 to $2,159,471 in 1919. The largest part of the gold was contained in ores produced in Salt Lake County and amounted to $1,399,557. Juab County ranked next with $495,153, against $628,593 in 1918. The Bingham district, with its large output of copper and other ores, produced $1,389,849 in gold in 1919, and the Tintic district, partly in Juab County and partly in Utah County, produced $535,534. There was no production of placer gold in 1919 and the output recovered by cyanidation and amalgamation was about $52,100. About 37 per cent of the Utah gold was derived from copper ores mainly mined in Salt Lake and Juab counties; lead and lead-zinc ores contained 39 per cent.

Silver.—The total output of silver in Utah from 1864 to 1919, inclusive, has been 391,126,085 fine ounces, according to Heikes.[8]

The mine production of silver in Utah in 1919 was 11,649,961 ounces, a decrease of 1,805,636 ounces. The largest production was from Juab County, credited with 4,822,227 ounces (mainly from lead ores), against 4,994,806 ounces in 1918. Utah County had the next largest output, 1,993,381 ounces (from copper, lead, and lead-zinc ores), against 1,734,489 ounces in 1918. Of the Salt Lake County output of silver, 1,937,006 ounces, the Bingham district produced 1,607,132 ounces. The Tintic district, in Juab and Utah counties, yielded 6,779,829 ounces (mainly from lead ores); and the Park City region, in Summit and Wasatch counties, produced 1,945,670 ounces, mainly from lead and lead-zinc ores. Altogether the lead ores of Utah yielded 6,664,219 ounces of silver in 1919, the copper ores 586,417 ounces, the lead-zinc ores 714,480 ounces, and the dry or siliceous ores 3,645,909 ounces. The crude ore smelted in 1919 contained 9,409,278 ounces and concentrates contained 1,592,613 ounces.

WASHINGTON.

The total production of gold in Washington from earliest mining to the end of 1919 is given by C. N. Gerry, of the United States Geo-

[7] U. S. Geol. Survey Mineral Resources, 1919, pt. 1.
[8] Idem, p. 417.

logical Survey, as $28,006,212, and the total production of silver as 7,622,917 fine ounces.[9]

Gold.—The mine production of gold in Washington in 1919 was $252,862, against $304,658 in 1918. Of the production in 1919 more than 98 per cent was derived from ores shipped directly to smelters, less than 1 per cent came from ores treated by amalgamation or cyanidation, and less than 1 per cent came from placers. Siliceous ores supplied about 98 per cent of all gold recovered and copper ores about 1 per cent. Ferry County alone produced $245,141 in 1919, against $276,066 in 1918. Nearly all the yield from Ferry County was, as usual, from the Republic district.

Silver.—The mine production of silver in Washington decreased from 310,093 ounces in 1918 to 259,384 ounces in 1919, of which Ferry County produced 65,864 ounces, mainly from siliceous ores, and Stevens County 156,562 ounces, mainly from copper ores.

WYOMING.

The total production of gold in Wyoming from 1867 to the end of 1919 is given by Charles W. Henderson as $1,236,059, and the output of silver for the same period as 69,691 ounces.

The mine production of gold in Wyoming in 1919 was $84, against $871 in 1918, and that of silver 151 ounces, against 965 ounces in 1918. Copper ores shipped from mines in Carbon and Platte counties contained nearly all the gold and silver reported in 1919.

PHILIPPINE ISLANDS.

The output of gold in the Philippine Islands from 1907 to 1919, inclusive, has been $10,359,244. The mine production of gold for 1919 was $1,309,722, against $1,290,000 in 1918, $1,408,161 in 1917, $1,514,200 in 1916, $1,320,900 in 1915, $1,371,514 in 1914, $868,362 in 1913, and $570,212 in 1912.

In 1919 about $217,000 in gold was recovered by dredging. Of the Philippine production of gold in 1919, Ambos Camarines district yielded $217,455; Masbate district, $634,033; and Mountain Province district, $454,672. The milling plant of the Benguet Consolidated Mining Co. in the Province of Luzon, the largest producer of gold in the Philippine Islands, is described in the Mining and Scientific Press of December 4 and 11, 1920.

The mine production of silver in the Philippine Islands in 1919 was 8,409 ounces and was recovered entirely from gold bullion refined.

NUMBER OF PRODUCING MINES.

The following table indicates the number of mines producing gold and silver in 1919. The placers are those in which the gold and the silver in natural alloy with the gold and, in a few placers, found also with platinum are recovered from gravels and sands, whether by hand washing, sluicing, hydraulicking, drifting (in frozen ground or ancient buried river channels), or by dredging. The deep mines are those producing gold and silver (from ores as distinguished from gravels) mainly from underground workings, including those whose

[9] Idem, p. 485.

ores are valuable chiefly for copper, lead, or zinc but which contribute precious metals as by-products. In addition to producing mines here enumerated, many properties were being prospected and developed (though prospecting and development were much less active than usual) without making any output in 1919, and many other mining claims were being held by assessment work only.

The enumeration of placer mines is less satisfactory than that of deep mines, because some of the operations are only temporary and individually small and because much of the production is made by transitory miners not regularly working placer ground. The unit so far as possible is, however, as for deep mines, not the operator, but the mining claim or group of claims.

Number of mines producing gold and silver in 1919.[a]

State or Territory.	Number of mines.		
	Placer.	Deep.	Total.
Alaska	554	23	577
Arizona	15	324	339
California	280	370	650
Colorado	11	453	464
Georgia	3	2	5
Idaho	72	138	210
Illinois	.....	3	3
Maine and Vermont	.....	4	4
Michigan	.....	11	11
Missouri	.....	3	3
Montana	62	395	457
Nevada	37	384	421
New Mexico	6	86	92
North Carolina	.....	1	1
Oregon	55	23	78
South Carolina	.....	2	2
South Dakota	3	9	12
Tennessee	.....	2	2
Texas	.....	2	2
Utah	.....	179	179
Washington	7	42	49
Wyoming	.....	4	4
	1,105	2,460	3,565

[a] Philippine Islands not included.

Number of mines producing gold and silver, 1906–1919.

Year.	Placer.	Deep.	Total.	Year.	Placer.	Deep.	Total.
1906	2,316	2,114	4,430	1914	1,815	3,158	4,973
1907	2,586	2,604	5,190	1915	1,720	3,597	5,317
1908	2,599	2,864	5,463	1916	1,530	3,765	5,295
1909	2,187	3,183	5,370	1917	1,552	3,811	5,363
1910	2,026	3,299	5,325	1918	1,414	3,287	4,701
1911	2,146	3,553	5,699	1919	1,105	2,460	3,565
1912	2,044	3,567	5,611				
1913	1,774	3,502	5,276	Average	1,915	3,197	5,112

Comparison of the figures for 1919 shows a net total decrease of 1,136 producing mines, following a decrease of 662 mines in 1918. The total number of properties operated in 1919 was 1,547 less than the average for the last 14 years. The number of placer properties worked in 1919 showed a decrease of 309, and the total was 1,211 less than the number operated in 1906. This is a natural result of the exhaustion of the rich gravels and of the acquisition of large areas of placer ground by dredge mining companies. The number of deep mines operated

decreased from 3,287 in 1918 to 2,460 in 1919, or 737 less than the average for 14 years. Owing to the high cost of labor and material in 1919 fewer deep mines were operated than in any other year since 1906.

In total number of operating mines California ranked first, followed in order by Alaska, Colorado, Montana, and Nevada. In number of placers Alaska led, followed by California and Idaho; and in deep mines Colorado led, followed by Montana, Nevada, and California.

ORE PRODUCTION, CLASSIFICATION, AND AVERAGE VALUE.

The best index of deep mining is, of course, the quantity, metallic content, and value of ore mined, rather than the number of mines or of operators. In the next following table are given the production of ore from mines producing gold and silver and the average extraction value of precious metals per ton.

The classification adopted is necessarily arbitrary in part. The complex nature of western ores, especially, and the gradations from one well-recognized class to another render essential a fixed terminology. The dry or siliceous ores comprise gold and silver ores proper, as well as fluxing ores carrying considerable quantities of iron and manganese oxides and very small quantities of gold and silver, and precious metal bearing ores carrying copper, lead, or zinc in quantities too low to classify them as copper, lead, zinc, or mixed ores. The distinction between gold and silver ores is not here made. The total number of silver mines and the total production of true silver ores are both very small. The copper ores include those containing 2.5 per cent or more of copper, or less than this percentage in the great disseminated copper deposits of the West and in the Lake Superior ores; in general, the lead ores are those containing 4.5 per cent or more of lead and the zinc ores are those containing 25 per cent or more of zinc, both irrespective of their precious-metal content; but ores of lower grades in lead and especially in zinc are treated profitably in many districts, and of course they are then classified as lead or zinc ores, as the case may be. The mixed ores are combinations of those enumerated.

The lead, zinc, and lead-zinc ores in many districts in the Eastern and Central States carry no appreciable quantity of gold or silver, and such ores are excluded from this report.

The total quantity of ore sold or treated from which gold or silver was produced decreased from 68,046,900 short tons in 1918, the largest output ever recorded, to 42,509,072 short tons in 1919. The total of such ores had increased more than 17,500,000 tons in the three years prior to 1919. In 1919 the quantity of copper ores sold or treated decreased more than 23,490,000 tons; zinc ores more than 121,600 tons; dry or siliceous ores about 400,000 tons; lead-zinc ores, 986,400 tons; and lead ores, 541,300 tons; but copper-lead ores increased about 2,000 tons. Arizona, Utah, Montana, Alaska, and Nevada led in quantity of ore, owing to the large output from copper mines in all the States other than Alaska, which yielded mainly siliceous ores; the ore from Arizona and Utah was mainly low-grade disseminated ore, and that from Montana came mainly from the Butte vein deposits. Nevada ore was mainly Ely copper ores, but included also siliceous ores from Goldfield, Tonopah, and other districts.

New Mexico, Colorado, California, Michigan, Idaho, and South Dakota were next, with an output consisting mainly of dry or siliceous ores from many districts in California, Colorado, and South Dakota and of copper ores from the low-grade ore bodies in New Mexico and Michigan.

Ore produced and average extraction value of gold and silver per ton in 1919.[a]

State or Territory.	Dry or siliceous ores.		Copper ores.		Lead ores.	
	Quantity (short tons).	Average value.	Quantity (short tons).	Average value.	Quantity (short tons).	Average value.
Alaska	3,262,573	$1.38	492,644	$1.24		
Arizona	294,675	13.45	13,347,182	.43	76,247	$7.49
California	1,212,142	7.52	486,433	1.065	15,652	14.679
Colorado	1,667,076	8.16	9,417	23.37	74,918	18.79
Georgia	3	17.33	350			
Idaho	48,251	11.36	51,546	5.75	1,149,951	4.67
Maine and Vermont			35,400	.21		
Michigan [b]			1,488,000	.30		
Montana	221,686	14.62	3,081,451	2.42	33,551	27.31
Nevada	783,567	14.13	2,363,189	.18	19,152	24.52
New Mexico	90,713	11.17	2,027,107	.25	6,904	9.81
North Carolina and South Carolina			33	3.60		
Oregon	67,953	7.24	28,220	7.99		
South Dakota	1,330,349	3.75			19	45.99
Tennessee [b]			555,018	.21		
Texas	54,467	11.03	16	1.25	27	100.37
Utah	239,688	19.21	5,884,118	.25	435,541	17.97
Washington	29,086	12.58	68,447	2.45	3,281	1.80
Wyoming			798	.27		
Total, 1919	9,302,229	6.25	29,919,369	.61	1,815,243	9.33
Percentage of tonnage	21.89		70.39		4.25	
Total, 1918	9,702,240	6.58	53,409,729	.50	2,356,585	8.24
Percentage of tonnage	14.26		78.49		3.46	

State or Territory.	Zinc ores.		Copper-lead and copper-lead-zinc ores.		Lead-zinc ores.		Total (short tons).
	Quantity (short tons).	Average value.	Quantity (short tons).	Average value.	Quantity (short tons).	Average value.	
Alaska							3,755,217
Arizona	2,038		7,261	$12.81			13,727,403
California	684	$16.595					1,714,911
Colorado	50,547	.67	1,690	27.18	116,120	$3.93	1,919,768
Georgia							353
Idaho	1,478	.65	19	29.63	206,150	2.69	1,457,395
Maine and Vermont							35,400
Michigan [b]							1,488,000
Montana			1,357	54.39	845,549	5.09	4,183,594
Nevada	4,867		4,996	2.87	12,060	9.76	3,187,831
New Mexico	28,064		320	22.37	2,890		2,155,998
North Carolina and South Carolina							33
Oregon							96,173
South Dakota							1,330,368
Tennessee [c]							555,018
Texas							54,510
Utah	976		1,924	23.01	183,176	6.94	6,745,423
Washington			65	38.77			100,879
Wyoming							798
Total, 1919	88,654	.52	17,632	15.97	1,365,945	4.91	42,509,072
Percentage of tonnage	.21		.04		3.22		100.00
Total, 1918	210,298	76	15,698	16.19	2,352,350	3.47	68,046,900
Percentage of tonnage	.31		.02		3.46		100.00

[a] Illinois, Missouri, the Philippine Islands, and Porto Rico not included; quantity of crude ore containing precious metals not known.
[b] Includes only copper ore yielding precious metals.
[c] Lead and zinc ores yielded no precious metals.

The large production of lead and lead-zinc ores in Idaho ranked that State before South Dakota, which produced ores that were mainly dry or siliceous.

The average extraction values in gold and silver were comparatively high for the siliceous ores of Arizona, Colorado, New Mexico, Nevada, Montano, Utah, Idaho, Texas, and Washington, and low for the larger ore bodies of California, South Dakota, and Alaska. Some of the States produced comparatively small quantities of copper ore carrying high extraction values in gold and silver, but the copper ores of the important copper-producing States showed low extraction values. The average recovery in gold and silver from the copper ores of Arizona was $0.43 a ton, Tennessee $0.21, Montana $2.42, Nevada $0.18, New Mexico $0.25, Utah $0.25, California $1.065, and Michigan $0.30. The lead ores of Utah showed an average recovery in gold and silver of $17.97 a ton, and the lead ores of Idaho only $4.67 a ton. Idaho produced the largest quantity of gold and silver bearing lead ores and Montana the largest quantity of lead-zinc ores. Utah yielded the next largest quantity of lead ore. About 21.89 per cent of the output of ore considered as producing gold and silver was dry or siliceous ore, against 14.26 per cent in 1918; 70.39 per cent was copper ore, against 78.5 per cent in 1918; 4.25 per cent was lead ore; 3.22 per cent was lead-zinc ore; 0.21 per cent was zinc ore; and 0.04 per cent was copper-lead ore. The average precious-metal extraction value per ton of siliceous ores of the United States decreased from $6.58 to $6.25, that of lead ores increased from $8.24 to $9.33, and that of copper-lead ores decreased from $16.19 to $15.97. The average gold and silver value of copper ores per ton was 51 cents in 1916, 49 cents in 1917, 50 cents in 1918, and 61 cents in 1919, and that of lead-zinc ores increased from $3.47 in 1918 to $4.91 in 1919.

DISTRIBUTION OF MINE PRODUCTION OF GOLD IN 1919, BY SOURCES.

As shown in the following table, more than 90 per cent of the domestic output of gold is obtained from dry or siliceous ore—normally gold quartz and gold-silver quartzose ores—and from placers. The total contribution of gold derived from the great copper, lead, and zinc mines of the country is therefore relatively small, notwithstanding their recent enormous development and production of ore.

The contribution of gold from dry or siliceous ores, which had gradually declined from about 69 per cent in 1910 to about 66 per cent in 1914 and had increased to nearly 68 per cent in 1915, decreased to less than 64 per cent in 1916, was 62 per cent in 1917, 63.7 per cent in 1918, and 64.67 per cent in 1919. The yield of gold from copper ores, which had increased from 6 per cent in 1914 to 9.6 per cent in 1918, decreased to 6.78 per cent in 1919.

Mine production of gold in 1919, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alaska	240,423.75	212,474.47	3,086.08					455,984.30
Arizona	227.07	135,941.83	78,103.32	3,701.41		24.09		217,997.72
California	388,600.05	411,139.78	6,137.17	1,784.40	5.42			807,666.82
Colorado	26,633.44	429,296.88	4,992.49	10,205.10	80.40	339.40	6,717.87	478,265.58
Georgia	34.59	2.51						37.10
Idaho	9,227.63	22,262.08	962.13	1,970.50		.58	79.97	34,502.89
Maine and Vermont			25.25					25.25
Montana	14,097.92	64,289.55	16,612.99	3,797.15		120.07	8,938.64	107,856.32
Nevada	6,399.43	194,008.03	16,254.92	2,481.11		511.52	40.15	219,695.16
New Mexico	239.89	19,722.06	11,295.02	445.59		14.80		31,717.36
North Carolina			.97					.97
Oregon	18,413.99	18,962.81	9,926.45					47,303.25
South Carolina		2.81	1.11					3.92
South Dakota	19.16	235,229.25		1.16				235,249.57
Tennessee			273.90					273.90
Texas				1.21				1.21
Utah		25,216.63	38,873.71	17,555.14		32.56	22,786.37	104,464.41
Washington	60.32	12,016.93	153.01	1.60		.34		12,232.20
Wyoming		1.74	2.32					4.06
Total	704,377.24	1,780,567.36	186,700.84	41,944.37	85.82	1,043.36	38,563.00	2,753,281.99
Value	$14,560,770	$36,807,594	$3,859,449	$867,067	$1,774	$21,568	$797,168	$56,915,390
Percentage of total	25.58	64.67	6.78	1.52	.01	.04	1.40	100.00
Total 1918	758,201.87	2,045,494.80	309,018.22	55,246.01	1,188.13	1,430.90	42,092.63	3,212,672.56
Value	$15,673,424	$42,284,130	$6,387,974	$1,142,036	$24,561	$29,579	$870,132	$66,411,836
Percentage of total	23.60	63.67	9.62	1.72	.04	.04	1.31	100.00

[a] Philippine Islands not included.

PLACERS.

GENERAL FEATURES.

The total value of the gold produced from placers was $14,560,770 in 1919 against $15,673,424 in 1918. The placer production in Alaska decreased by 44,989 ounces, owing to the scarcity of labor and the high cost of supplies. The decrease in placer gold from Montana was 5,070 ounces; from Nevada, 4,165 ounces; from Oregon, 5,689 ounces; from Idaho, 4,144 ounces. The only States showing a considerable increase in gold produced from placers were California, with an increase of 9,400 ounces, and Colorado, with 1,178 ounces.

The placer gold is derived chiefly from dredging, from drift mining (which is of decreasing importance in Alaska in frozen ground at no great depth, but of continued importance in California in ancient buried river channels, often at considerable depth), and from hydraulic and sluicing placers. In California, especially, hydraulic mining was of much importance in the past and had become a special branch of the industry in itself, but restrictive laws relative to the débris and to disturbance of navigable streams have in recent years greatly confined mining activity of this kind. Finally, there is a small annual output of gold from dry placers in the Southwest and also a production of gold and platinum from ocean-beach mining in California and Oregon.

Some interesting notes on beach mining in California and Oregon and on dry placers in California, by Charles G. Yale, and on dry

placers in Arizona, Nevada, and New Mexico, by V. C. Heikes, were published in the Survey report on gold and silver for 1912, copies of which may still be had on application to the Director, United States Geological Survey, Washington, D. C.

DREDGING.

The production of gold by dredging in the United States from the commercial beginning of the industry in 1896 to the end of 1919 has amounted in value, according to best available data, to $153,342,048, of which $110,342,831 came from California, $20,394,894 from Alaska, $9,109,528 from Montana, $5,815,943 from Colorado, and $4,096,118 from Idaho. Oregon produced more gold from dredging in 1916, 1917, 1918, and 1919 than Montana or Idaho and nearly as much as Colorado, and the total production from dredges in Oregon has been about $3,196,000.

Brief details of dredging operations have been given in Mineral Resources in the mines reports on gold, silver, copper, lead, and zinc in the Western States and also in earlier reports of the Director of the Mint. A brief history of gold dredging in the United States was given in the general report on gold and silver for the year 1914, and the production of gold obtained by dredging in the United States and the number of dredges operated were given by States for each year from 1896 to the end of 1914. Further information is to be found in reports of geological surveys or mining officials of different States. A comprehensive and very useful report is contained in Bulletin 57 of the California State Mining Bureau. Other valuable treatises are "Dredging for gold in California," by D'Arcy Weatherbe, published by the Mining and Scientific Press, and Bulletins 121 and 127 of the Bureau of Mines.

The gold recovered in the United States by 91 gold dredges in 1919 was $10,346,216, against $10,342,100 by 93 dredges in 1918. The increase in 1919 was $4,116, following a decrease of $2,208,325 in 1918. Of the output in 1919, California produced $7,716,919 from 46 dredges, Alaska $1,360,000 from 28 dredges, Montana $265,590 from 3 dredges, Colorado $542,103 from 6 dredges, Idaho $164,854 from 5 dredges, and Oregon $296,750 from 3 dredges. No dredges were operated in 1919 in Nevada, Wyoming, South Dakota, or the Appalachian States, but a dredge was under construction in Nevada, and it was operated in 1920. There was also an output of $217,455 in gold from dredges operated in the Philippine Islands in 1919, but this is not included in the table given on page 694.

Gold produced in the United States by dredges, 1896–1919.

Year.	Dredges.	California.	Alaska.	All other States.[a]	Total.
1896	2	$2,000	.....	$42,000	$44,000
1897	6	5,000	.....	113,556	118,556
1898	8	18,887	.....	168,813	187,700
1899	18	206,302	.....	227,876	434,178
1900	27	200,929	.....	319,108	520,037
1901	34	471,762	.....	268,251	740,013
1902	48	867,665	.....	501,857	1,369,522
1903	45	1,475,749	$20,000	420,315	1,916,064
1904	61	2,187,038	25,000	511,679	2,723,717
1905	68	3,276,141	40,000	371,235	3,687,376
1906	76	5,098,359	120,000	503,035	5,721,394
1907	79	5,065,437	250,000	340,265	5,655,702
1908	88	6,536,189	170,901	646,481	7,353,571
1909	96	7,382,950	424,993	975,656	8,783,599
1910	115	7,550,254	800,000	942,786	9,293,040
1911	119	7,666,461	1,500,000	1,159,908	10,326,369
1912	124	7,429,955	2,200,000	1,588,956	11,218,911
1913	116	8,090,294	2,200,000	1,936,642	12,226,936
1914	120	7,783,394	2,350,000	2,379,389	12,512,783
1915	114	7,796,465	2,330,000	2,356,660	12,483,125
1916	113	7,769,227	2,679,000	2,338,487	12,786,714
1917	109	8,313,527	2,500,000	1,736,898	12,550,425
1918	93	7,431,927	1,425,000	1,485,173	10,342,100
1919	91	7,716,919	1,360,000	1,269,297	10,346,216
	.....	110,342,831	20,394,894	22,604,323	153,342,048

[a] Other States that have produced gold by dredges are Colorado, which yielded, 1901–1919, $5,815,943; Idaho, 1897–1919, $4,096,118; Montana, 1896–1919, $9,109,528; and Oregon, New Mexico, Nevada, South Dakota, Wyoming, Alabama, Georgia, and North Carolina, a combined yield, 1902–1919, of $3,582,734.

DRY AND SILICEOUS ORES.

In 1919 dry and siliceous ores, including true gold, gold-silver, and silver ores and precious-metal ores not classed primarily as copper, lead, zinc, or mixed ores, produced $36,807,594 in gold, against $42,284,130 in gold in 1918 and $49,963,518 in 1917. The largest producers from ores of this class were Colorado, California, South Dakota, Alaska, Nevada, and Arizona. In 1919 deep mines in the Philippine Islands yielded $1,092,267 from siliceous ores, but the output is not included in the table.

The siliceous ores are in part free-milling (amalgamating), as in Alaska, California, Arizona, and Oregon; both amalgamating and concentrating, as in many States; simply concentrating ores, as in parts of Colorado and Arizona; all-sliming and cyaniding ores; and finally smelting ores. Tailings both from old dumps and from present millings are largely reworked by concentration and subsequent cyanidation. Owing to the increase in the cost of labor and supplies in the last three or four years, much of the old tailings could not be reworked at a profit.

The material smelted consists mainly of concentrates and of siliceous and pyritic ores, which are also valuable as fluxes. Exact figures of relative output by methods and by States are given in another table.

As most of the production of gold in the United States is derived from placer gravels and dry or siliceous ores, including true gold, gold-silver, and silver ores, the following table for certain States, prepared by V. C. Heikes, of the United States Geological Survey, is of special interest.

Gold produced in six Western States in 1918–1919.

Year.	Total number of producers.	Total quantity of ore mined.	Total gold.[a]	Gold ore.			
				Number of producers.	Quantity.	Gold.	Average content.
Arizona:		*Short tons.*	*Fine ounces.*		*Short tons.*	*Fine ounces.*	*Ounce.*
1913	438	7,931,862	194,656.69	116	210,228	120,351.91	0.572
1914	395	8,009,927	202,166.62	121	263,895	136,558.47	.517
1915	517	9,612,559	201,531.46	139	182,251	92,771.19	.509
1916	527	17,033,810	192,801.41	105	164,918	63,562.20	.385
1917	484	15,770,193	245,173.83	86	236,585	128,801.16	.544
1918	469	19,038,486	262,919.43	63	201,411	141,126.29	.700
1919	339	13,727,403	217,997.72	34	190,069	125,188.13	.659
Idaho:							
1913	384	2,451,592	65,043.04	76	36,729	15,074.89	.410
1914	384	2,235,349	55,743.24	84	37,098	13,407.04	.361
1915	412	2,408,846	57,069.49	102	51,786	21,681.77	.419
1916	418	2,718,045	53,977.30	75	69,443	25,068.38	.361
1917	359	2,758,507	38,932.64	70	67,784	24,721.63	.365
1918	301	2,091,619	33,998.72	53	41,481	13,774.92	.332
1919	210	1,457,395	34,502.89	31	44,537	21,989.06	.493
Montana:							
1913	558	5,960,118	168,994.77	182	229,520	84,748.32	.369
1914	505	5,128,956	199,203.94	183	315,804	116,964.96	.370
1915	643	6,129,924	242,077.93	225	466,818	150,169.29	.322
1916	513	7,860,425	220,130.15	150	498,082	131,175.61	.263
1917	617	6,307,164	170,147.11	137	411,118	103,835.48	.252
1918	493	7,823,967	150,192.96	90	234,663	74,996.31	.320
1919	457	4,183,594	107,856.32	87	130,922	56,301.56	.430
Nevada:							
1913	786	5,367,211	570,589.41	323	772,749	338,770.66	.438
1914	731	4,522,022	555,402.47	310	837,699	334,137.48	.399
1915	799	5,118,620	551,683.01	206	959,304	335,907.39	.348
1916	779	5,941,165	428,904.21	308	817,100	232,699.56	.285
1917	943	6,473,519	336,664.26	287	589,228	171,815.15	.292
1918	714	6,472,579	320,239.45	195	540,320	167,878.58	.311
1919	421	3,187,831	219,695.16	94	163,279	111,170.33	.681
Utah:							
1913	217	10,202,566	172,467.95	5	68,408	11,974.24	.175
1914	211	8,544,014	157,961.16	5	1,987	856.32	.430
1915	234	10,451,445	174,590.65	7	13,883	3,226.24	.232
1916	318	13,920,643	172,938.06	10	1,308	663.82	.508
1917	334	15,358,481	162,305.67	6	14,728	4,678.60	.318
1918	250	14,705,718	142,666.10	10	222	359.70	1.620
1919	179	6,745,423	104,464.41	6	553	1,528.81	2.764
Washington:							
1913	57	15,685	33,682.30	26	56,008	31,943.93	.570
1914	67	95,947	26,953.24	22	73,618	26,184.86	.356
1915	104	86,677	18,934.90	46	41,412	18,223.36	.440
1916	113	164,998	27,944.06	38	70,048	26,932.84	.384
1917	136	172,119	23,816.17	23	65,058	23,166.31	.356
1918	84	138,911	14,737.83	23	45,434	14,070.56	.309
1919	49	100,879	12,232.20	11	25,648	11,951.91	.465

[a] Includes placer production, given in last column on p. 696.

Gold produced in six Western States in 1913–1919—Continued.

Year.	Gold-silver ore.		Silver ore.		Placers.	
	Quantity.	Gold.	Quantity.	Gold.	Number of producers.	Gold.
Arizona:	*Short tons.*	*Fine ounces.*	*Short tons.*	*Fine ounces.*		*Fine ounces.*
1913	1,261	406.82	32,216	1,858.40	36	1,484,67
1914	58	46.78	128,759	8,230.65	57	1,458.02
1915	14,349	2,338.97	144,198	9,189.84	49	1,705.12
1916	1,470	994.00	169,916	8,858.47	23	690.84
1917	1	3.62	80,817	3,192.79	32	832.73
1918	2,415	452.21	91,722	8,421.19	13	204.82
1919	19,536	6,474.19	85,070	4,279.51	15	227.07
Idaho:						
1913	23,390	7,238.56	206	27.82	235	33,574.81
1914	44	92.42	1,100	176.56	208	33,884.46
1915	119	90.81	397	162.87	186	28,294.05
1916	447	227.19	1,793	201.15	162	21,724.87
1917	.....	.....	1,866	207.64	112	6,541.80
1918	.....	.....	4,834	478.53	85	13,371.33
1919	21	15.94	3,693	257.08	72	9,227.63
Montana:						
1913	13,586	3,763.07	41,382	4,237.81	152	38,748.47
1914	427	451.46	25,854	4,182.65	147	45,579.75
1915	1,025	125.64	25,657	4,760.58	161	45,219.87
1916	999	176.45	24,761	4,075.20	120	34,982.82
1917	7	2.20	33,097	3,335.15	99	22,594.17
1918	233	121.33	51,626	5,495.86	86	19,167.72
1919	118	61.58	90,646	7,926.41	62	14,097.92
Nevada:						
1913	72,909	27,115.32	697,775	144,961.52	64	14,775.75
1914	6,878	3,929.80	676,573	146,181.17	111	18,250.05
1915	16,558	5,372.05	721,753	127,079.12	103	19,123.55
1916	13,330	2,681.38	721,211	116,039.39	65	17,139.89
1917	17,614	3,099.45	807,087	93,757.16	91	14,153.75
1918	14,384	3,157.77	839,879	82,026.71	54	10,564.13
1919	68,874	28,478.76	551,414	54,358.94	37	6,399.43
Utah:						
1913	82,165	16,425.10	73,294	4,172.90	7	92.88
1914	77,653	11,901.80	69,379	5,508.11	7	59.55
1915	11,135	1,534.16	36,958	4,488.27	6	46.34
1916	4,337	1,130.41	83,718	7,328.18	8	60.47
1917	25,318	4,864.68	124,011	10,851.33	3	5.42
1918	5	101.75	227,129	22,353.99	3	66.18
1919	14,618	3,489.71	224,517	20,198.11	.....	.....
Washington:						
1913	4	58.00	120	23.00	12	200.00
1914	.....	.....	274	269.00	17	278.45
1915	.....	.....	748	54.36	31	346.00
1916	.....	.....	428	46.19	23	400.40
1917	48	30.89	533	43.41	17	283.86
1918	.....	.....	1,717	36.80	10	165.93
1919	.....	.....	3,438	65.02	7	60.32

Nearly all the siliceous ore in three of the largest gold-producing States—Alaska, California, and South Dakota—yields only small values in silver and is classed as gold ore. The siliceous ores from Colorado include some silver and gold-silver ores, but the great bulk of the siliceous ore is purely gold ore.

Siliceous ore treated and gold recovered per ton of ore treated in 1913–1919.

Year.	Alaska.		California.		South Dakota.		Colorado.	
	Ore treated.	Recovery per ton.	Ore treated.	Recovery per ton.	Ore treated.	Recovery per ton.	Ore treated.	Recovery per ton.
	Short tons.	*Ounces.*	*Short tons.*	*Ounces.*	*Short tons.*	*Ounces.*	*Short tons.*	*Ounces.*
1913	1,614,506	0.144	2,031,429	0.267	1,899,139	0.187	2,161,458	0.378
1914	1,738,127	.135	2,050,797	.264	2,019,255	.175	2,157,762	.414
1915	3,020,607	.097	2,368,352	.272	1,889,970	.189	2,183,431	.464
1916	3,548,798	.081	2,192,078	.262	1,870,721	.193	2,057,452	.412
1917	3,414,664	.065	2,018,003	.246	1,867,859	.191	1,995,590	.347
1918	2,095,577	.080	1,538,960	.261	1,781,569	.178	1,760,222	.322
1919	3,262,573	.068	1,212,142	.339	1,330,349	.177	1,657,076	.258

There was an increase of nearly 1,167,000 tons in the quantity of siliceous ores treated in Alaska in 1919, compared with 1918, and the gold content of the ore treated in 1919 was 44,453 ounces more, though the recovery per ton was less. The quantity of siliceous ore milled in South Dakota decreased 451,000 tons and the recovery of gold was less; that of California decreased about 327,000 tons, but the gold recovery per ton was the largest recorded for six years.

COPPER ORES.

The gold obtained as a by-product in the smelting of copper ores sold or treated in 1919 amounted to $3,859,449, against $6,387,974 in 1918, a decrease from 9.62 per cent of the total gold yield in 1918 to 6.78 per cent in 1919. The largest production was in Arizona, followed by Utah, Montana, Nevada, New Mexico, and Oregon. The largest decreases were in Utah, Nevada, Arizona, Montana, California, Idaho, and Alaska, caused by a smaller output of copper in those States. Colorado and Oregon were the only States that had any notable increase in gold derived from copper ores.

LEAD ORES.

The production of gold in lead ores sold or treated in 1919, chiefly from Utah and Colorado, was $867,067, against $1,142,036 in 1918, or 1.52 per cent of the total domestic output of gold in 1919.

LEAD-ZINC, ZINC, AND OTHER ORES.

The production of gold from lead-zinc ores in 1919 was $797,168 against $870,132 in 1918 and $765,316 in 1917; from zinc ores $1,774 in 1919, against $24,561 in 1918; and from copper-lead and copper-lead-zinc ores in 1919 was $21,568, against $29,579 in 1918. Utah, Montana, and Colorado produced nearly all the gold from lead-zinc ores and Colorado nearly all the gold from zinc ores. Nevada, Colorado, and Montana contributed nearly all the gold from copper-lead ore.

DISTRIBUTION OF MINE PRODUCTION OF SILVER IN 1919, BY SOURCES.

Mine production of silver in 1919, in fine ounces.[a]

State or Territory.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
Alaska	32,983	108,691	488,034					629,708
Arizona	36	1,031,185	3,711,052	441,739		82,593		5,266,605
California	27,924	547,541	349,480	172,209	10,035			1,107,189
Colorado	7,143	4,231,053	104,381	1,068,360	28,583	34,749	283,741	5,758,010
Georgia	8							8
Idaho	1,902	78,531	246,983	4,757,259	862	492	493,027	5,579,056
Illinois[b]				4,440				4,440
Maine			4,142					4,142
Michigan			441,430					441,430
Missouri			29,480	60,921				90,401
Montana	2,309	1,707,053	6,341,825	747,960		63,681	3,678,353	12,541,181
Nevada	2,374	6,306,583	73,371	373,518		3,345	101,389	6,863,580
New Mexico	33	540,734	238,271	52,263		6,117		837,418
North Carolina			19					19
Oregon	3,670	89,297	18,154					111,121
South Carolina		2	17					19
South Dakota	1	115,733		759				116,493
Tennessee			98,288					98,288
Texas		536,222	25	2,395				538,642
Utah		3,645,909	586,417	6,664,219		38,936	714,480	11,649,961
Vermont			2,214					2,214
Washington	18	104,980	146,891	5,251		2,244		259,384
Wyoming		1	150					151
Total, 1919	78,401	19,043,515	12,880,624	14,351,293	39,480	232,157	5,273,990	51,899,460
Value	$87,809	$21,328,736	$14,426,299	$16,073,448	$44,218	$260,016	$5,906,869	$58,127,395
Percentage of total	0.15	36.69	24.82	27.65	0.08	0.45	10.16	100.00
Total, 1918	89,494	21,564,982	20,462,597	18,291,243	135,676	224,580	7,290,380	68,058,952
Value	$89,494	$21,564,982	$20,462,597	$18,291,243	$135,676	$224,580	$7,290,380	$68,058,952
Percentage of total	0.13	31.68	30.07	26.89	0.20	0.33	10.70	100.00

[a] Philippine Islands not included. [b] Fluorspar-lead ore.

The mine production of silver from the three most important sources of silver, dry or siliceous ores, copper ores, and lead ores was 89.16 per cent of the total output in 1919 against 88.6 per cent of the total output in 1918. The percentage of the total output from dry and siliceous ores increased 5.01 per cent in 1919, following an increase of 1.27 per cent in 1918; that from lead ores increased 0.76 per cent in 1919; that from lead-zinc ores decreased 0.54 per cent and that from copper ores 5.25 per cent. The combined yield of silver from placers, zinc ores, and copper-lead ores was only 0.68 per cent of the total.

PLACERS.

The output of silver from the refining of placer gold was 78,401 fine ounces in 1919, against 89,494 fine ounces in 1918, and 118,604 ounces in 1917. Of the total production 78 per cent came from Alaska and California.

DRY AND SILICEOUS ORES.

The mine production of silver from dry and siliceous ores in 1919 was 19,043,515 fine ounces, against 21,564,982 fine ounces in 1918. About 33 per cent of this was from Nevada (chiefly from the Tonopah district) and 22.2 per cent was from Colorado (mainly from the

Leadville, Upper San Miguel, and Sneffels districts). The quantity of silver from siliceous ores mined in Utah decreased from 3,987,068 ounces in 1918 to 3,645,909 ounces in 1919. There were decreases in many of the States, especially in Nevada, where the production in 1919 was 2,845,793 ounces less than in 1918 and 6,445,328 ounces less than in 1916. Arizona and Montana also each produced more than 1,000,000 ounces of silver from this source, California 547,541 ounces, and New Mexico nearly 541,000 ounces, and the production of silver in these States from siliceous ores increased considerably. More than 99 per cent of the 538,642 ounces of silver produced in Texas was from siliceous silver ores.

A large part of the silver from gold-silver siliceous ores is obtained with the gold by amalgamation and cyanidation in the mills, and the silver is recovered by refining the mill bullion. The remainder is produced by smelting the richer ores and refining the copper or lead bullion produced. A small quantity of silver was also recovered from the leaching of copper ores.

COPPER ORES.

The mine production of silver from domestic copper ores in 1919 was 12,880,624 fine ounces, against 20,462,597 fine ounces in 1918. The decrease in production of silver from copper ores mined in Alaska was 231,357 ounces; Utah, 859,142 ounces; Nevada, 205,244 ounces; Michigan, 68,037 ounces; California, 320,231 ounces; Montana, 4,179,394 ounces; and Arizona, 1,636,566 ounces.

The silver produced from copper ores is obtained in the electrolytic refining of Lake and blister copper produced by smelting. The copper ores are mainly sulphides (except the Lake ores of Michigan, which are native metal in amygdaloid and conglomerate matrix), and a greater quantity contains chalcocite than chalcopyrite or cupriferous pyrite. The silver tenor of the extensive disseminated deposits of the Santa Rita district, N. Mex., and of Ely, Nev., is notably low, but similar deposits elsewhere add considerable quantities of silver.

In output of silver from copper ores Montana continued to lead with 6,341,825 ounces in 1919, against 10,521,219 ounces in 1918. Arizona was next with 3,711,052 ounces in 1919, against 5,347,618 ounces in 1918; Utah ranked third with 586,417 ounces in 1919, against 1,445,559 ounces in 1918; and California produced only 349,480 ounces in 1919, against 669,711 ounces in 1918. The production of Montana comes mainly from Butte, that of Arizona chiefly from Bisbee and Jerome, that of Utah from Tintic and Bingham, and that of California from Plumas, Shasta, and Calaveras counties. Of these districts Bisbee well represents the disseminated type; Bingham produces from both lode and disseminated deposits; and the remainder produce silver chiefly from copper ore mined from deep lodes.

LEAD ORES.

The mine production of silver from argentiferous lead ores in 1919 was 14,351,293 fine ounces, against 18,291,243 fine ounces in 1918 and 19,096,474 ounces in 1917. The output from Idaho decreased

from 8,036,361 ounces in 1918 to 4,757,259 ounces in 1919, that of Utah decreased from 6,672,725 ounces to 6,664,219 ounces, and that of Colorado decreased 387,663 ounces. The yield in Idaho is derived mainly from the silver-lead ores of the Coeur d'Alene, that in Utah chiefly from the Park City and Tintic districts, and that in Colorado from Aspen and Leadville. The production of silver from lead ores in California decreased from 448,547 ounces in 1918 to 172,209 ounces in 1919, and there was also a decrease in Nevada; but there was an increase of about 80,000 ounces in Arizona, 40,000 ounces in Montana, and 22,000 ounces in Missouri. Most of the output is obtained from the desilverization of lead bullion from smelting of western ores and concentrates.

ZINC, LEAD-ZINC, AND MIXED ORES.

Argentiferous zinc ores produced 39,480 ounces of silver in 1919, against 135,676 ounces in 1918, mainly as refinery by-products from the smelting of zinc concentrates from Colorado and California.

Lead-zinc ores produced 5,273,990 fine ounces of silver in 1919, against 7,290,380 ounces in 1918, chiefly from concentrates from the Coeur d'Alene region in Idaho, the Butte district in Montana, and the Park City region in Utah. The output from Idaho decreased from 794,449 ounces in 1918 to 493,027 ounces in 1919. The production of silver from lead-zinc ores in Montana decreased from 4,532,034 ounces in 1918 to 3,678,353 ounces in 1919 and in Utah from 1,243,638 ounces in 1918 to 714,480 ounces in 1919.

Copper-lead and copper-lead-zinc ores produced 232,157 ounces of silver in 1919, against 224,580 ounces in 1918. The output was mainly from Arizona, Montana, Colorado, and Utah.

PRODUCTION OF SILVER, BY SOURCES, 1905–1919.

Silver produced in the United States, by sources, as reported by mines, 1905–1919, in fine ounces.[a]

Year.	Placers.	Dry or siliceous ores.	Copper ores.	Lead ores.	Zinc ores.	Copper-lead and copper-lead-zinc ores.	Lead-zinc ores.	Total.
1905	112,826	17,187,889	15,762,947	16,070,203	939,252	5,416,723	782,656	56,272,496
1906	171,058	16,792,799	15,880,870	15,328,653	98,423	6,815,678	2,274,972	57,362,453
1907	126,808	19,038,042	13,955,436	17,318,811	93,419	489,825	1,474,725	52,497,066
1908	159,285	19,862,038	14,945,189	14,049,481	37,605	1,099,283	722,906	50,875,787
1909	152,040	19,826,890	18,300,705	17,027,737	313,948	549,923	1,141,434	57,312,677
1910	159,381	23,125,042	16,024,543	15,028,076	755,369	535,987	1,968,311	57,596,709
1911	170,084	25,205,749	16,759,638	15,596,638	630,573	285,006	2,460,152	61,107,840
1912	163,955	26,363,436	18,744,661	16,632,377	664,421	654,596	2,810,939	66,034,385
1913	123,739	28,010,875	18,250,253	18,629,246	86,432	752,563	5,334,120	71,187,228
1914	152,128	27,812,335	14,829,828	19,302,081	145,264	248,866	7,132,747	69,623,249
1915	154,968	25,709,505	18,781,365	19,828,533	1,136,220	234,047	6,509,092	72,353,730
1916	126,351	24,593,656	24,541,234	19,216,586	1,274,292	533,273	8,572,141	78,857,533
1917	118,604	21,489,465	20,314,233	19,096,474	549,656	448,042	8,645,038	70,661,512
1918	89,494	21,564,982	20,462,597	18,291,243	135,676	224,580	7,290,380	68,058,952
1919	78,401	19,043,515	12,880,624	14,351,293	39,480	232,157	5,273,990	51,899,460
	2,059,122	335,626,218	260,434,123	255,767,432	6,900,030	18,520,549	62,393,603	941,701,077

[a] Philippine Islands excluded.

This table shows that the production of silver as reported by the mines had increased from 50,875,787 fine ounces in 1908 to 78,857,533 ounces in 1916, and that the production in 1919 was about 26,958,000 ounces less than it was in 1916. The production from siliceous ores in 1919 was 2,521,000 ounces less than in 1918. The recovery from dry or siliceous ores was greatest in 1913, when the yield from Tonopah mines was at its zenith, and the production in 1919 was about 8,967,000 ounces less than it was in 1913. The yield of silver from copper ores which was 20,462,597 ounces in 1918, decreased 7,582,000 ounces in 1919. The total yield of silver from zinc ores has been comparatively small; the annual output increased from 37,605 ounces in 1908 to 1,274,292 ounces in 1916, but decreased to 39,480 ounces in 1919. The combined production of silver from lead and lead-zinc ore decreased from 25,581,623 ounces in 1918 to 19,625,283 ounces in 1919.

The production of silver from siliceous ores probably increased slightly in 1920 and that from copper ores and lead ores may have decreased considerably, owing to the smaller output of those metals in 1920.

DISTRIBUTION OF PRODUCTION OF GOLD AND SILVER BY METHODS OF TREATMENT.

SUMMARY OF DISTRIBUTION.

In the following table is given the recoverable gold and silver content of the ore, tailings, and slag treated.

Distribution of gold and silver produced in 1919, by States.[a]

State or Territory.	Total quantity of crude ore, tailings, and slag treated or sold in 1919.	Crude ore to gold and silver mills.			Crude ore to concentrating mills (quantity).	Concentrates produced from all sources.		
		Quantity.	Gold in bullion.	Silver in bullion.		Quantity.	Gold.	Silver.
	Short tons.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska	3,755,217	2,996,462	151,227	34,333	717,556	65,260	61,448	452,848
Arizona	13,727,403	193,460	124,944	117,641	9,596,953	641,649	16,964	1,085,082
California	1,714,911	1,070,010	306,783	112,726	479,758	54,405	101,683	226,850
Colorado	1,919,768	1,195,986	346,035	242,269	439,373	100,775	60,259	2,123,721
Idaho	1,457,395	40,844	15,554	5,264	1,171,102	196,811	6,701	3,972,416
Montana	4,183,594	105,044	35,347	84,941	3,089,433	1,140,668	25,443	9,284,128
Nevada	3,187,831	638,784	167,180	5,600,563	2,300,463	283,511	18,357	281,454
New Mexico	2,155,998	74,167	17,990	321,303	1,987,943	155,136	4,655	179,760
Oregon	96,173	62,480	18,748	47,642	32,868	7,339	10,168	39,342
South Dakota	1,330,368	1,329,481	232,834	114,257	640	60	11	620
Texas	54,510	54,467		536,222				
Utah	6,745,423	14,614	2,520	64,473	5,985,365	381,085	54,268	1,592,613
Washington	100,879	7	6	1	70,054	3,936	173	117,847
Wyoming	798	2	2	1				
Eastern or Appalachian States[b]	590,454	3	5	2	35,400	3,076	25	6,356
Total, 1919	41,020,722	7,775,811	1,418,875	7,281,638	25,906,908	3,033,711	360,155	19,363,037
Total, 1918	65,240,900	8,121,428	1,669,681	9,923,457	45,135,544	5,357,214	438,450	27,106,268

[a] Exclusive of silver from copper ores in Michigan and Missouri and from lead ores in Illinois and Missouri and of gold and silver from the Philippine Islands.

Distribution of gold and silver produced in 1919, by States—Continued.

State or Territory.	Crude ore to smelters.			Old tailings and slag treated.		
	Quantity.	Gold.	Silver.	Quantity.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*	*Fine ounces.*	*Fine ounces.*
Alaska	41,199	2,886	109,544			
Arizona	2,334,410	74,730	3,971,687	1,602,580	1,133	92,159
California	112,247	6,713	695,012	52,896	3,888	44,677
Colorado	284,409	45,338	3,384,877			
Idaho	79,399	3,020	1,599,474	166,050	(a)	(a)
Montana	294,268	31,652	3,006,765	694,849	1,316	163,038
Nevada	210,612	27,446	962,755	37,972	313	16,434
New Mexico	93,888	8,832	336,322			
Oregon	792	185	19,880	33	88	587
South Dakota	247	2,386	1,615			
Texas	43	1	2,420			
Utah	607,840	45,849	9,409,278	137,604	1,827	583,597
Washington	30,818	11,993	141,518			
Wyoming	796	2	150			
Eastern or Appalachian States[b]	555,051	276	98,321			
Total, 1919	4,646,019	261,309	23,739,621	2,691,984	8,565	900,492
Total, 1918	7,816,091	336,934	29,298,637	4,167,837	9,404	1,076,519

[a] Included under concentrates.
[b] Copper, lead, and zinc ores containing no silver excluded.

The first item takes no account of placer gravel but represents output of mines producing ore only. The greatest output was from Arizona, Utah, Montana, Nevada, and New Mexico—all notable for large yield of copper ores—and from Alaska.

Many gold and silver mills employ concentrating apparatus, and the concentrates they obtain are combined in the table with those from straight concentrating mills under the heading "Concentrates produced." The gold and silver included in this item is recovered mainly by amalgamation and cyanidation, as is shown in detail in the last table of this report. The greatest quantities milled were in Alaska, South Dakota, Colorado, California, and Nevada. The gold recovered in the mills was, as usual, chiefly from Colorado, California, South Dakota, Nevada, Alaska, and Arizona.

The silver recovered came very largely from Nevada (Tonopah, Wonder, and Rochester districts chiefly) and in much smaller quantities from Texas, New Mexico, Colorado, and Arizona.

The figures for the quantity of ore treated by concentration only include the large quantities of copper, lead, zinc, and mixed ores whose concentrates are smelted primarily for these metals, the gold and silver being recovered in refining the copper and lead bullion and smelting the zinc residues. Examples are the copper ores of the disseminated deposits of Bingham, Utah, and of New Mexico and Nevada; the copper ores of Butte, Mont.; and the lead and lead-zinc ores of Coeur d'Alene, Idaho, Butte, Mont., and Leadville, Colo. The quantity of concentrates produced and the recoverable gold and silver content represent not only the concentrates from these straight concentrating mills but also those from gold and silver mills, which form, however, a very small part of the total quantity of concentrates and are derived mainly from Alaska, California, and Colorado ores. These concentrates are mainly smelted but are also treated in gold and silver mills by the processes named.

The ore treated in straight concentration mills decreased notably in 1919, mainly because of less activity at copper mines in Montana, Arizona, and other States. Arizona ranked first in quantity of ore concentrated, followed by Utah, Montana, Nevada, New Mexico, and Idaho. These quantities, except those of Montana and Idaho, represent largely low-grade disseminated copper ores milled. Montana mills produced the largest quantity of concentrates, followed by those of Arizona, Utah, Nevada, Idaho, and New Mexico. The recoverable gold content of concentrates came mainly from California, Alaska, Colorado, Utah, Montana, and Nevada. About 68 per cent of the recoverable silver from concentrates produced came from Montana and Idaho; and large quantities came from Colorado, Utah, Arizona, Alaska, and Nevada. The decrease was due largely to a smaller output in the silver in concentrates derived from ores mined in Montana and Idaho.

The quantity and the recoverable precious-metal content of crude ores shipped from the mines direct to the smelters in general include the richer gold, silver, copper, lead, and mixed ores from which the gold and silver is eventually recovered by refining the copper or lead bullion that collects the precious metals in the smelting. Arizona produced 50 per cent of the ore directly smelted and was followed by Utah, Tennessee, Montana, Colorado, Nevada, and California. The gold from crude ores smelted came chiefly from Arizona, Utah, Colorado, Montana, Nevada, and Washington. The recoverable silver output came notably from Utah, Arizona, Colorado, Montana, Idaho, Nevada, California, and New Mexico. Utah and Arizona produced more than 56 per cent of the silver recovered from crude ore smelted.

The old materials, principally tailings and slags, re-treated (with which are included ore and tailings leached) are partly smelted, often for their fluxing as well as their metal value; but considerable quantities of old tailings are now concentrated and cyanided, and the impounding of mill tailings for future treatment as well as because of legal requirements has become a general practice. The decrease in quantity of old material treated in 1919 was due mainly to the high cost of labor and supplies, which made the treatment of tailings unprofitable. Most of the gold and silver derived from old tailings is included under recoveries by amalgamation and cyanidation at gold and silver mills. The total quantity of ore leached in 1919 was 1,885,776 short tons, of which 1,543,373 tons was from Arizona mines, 68,137 from Utah mines, 272,084 tons from Montana mines, and 1,182 tons from Nevada mines.

PERCENTAGE PRODUCED BY DIFFERENT PROCESSES.

Percentage of output of gold and silver produced by different processes, 1914–1919.

Process.	Percentage of total output.											
	Gold.						Silver.					
	1914	1915	1916	1917	1918	1919	1914	1915	1916	1917	1918	1919
Placers	25.2	22.7	25.0	25.8	23.6	25.6	0.2	0.2	0.2	0.2	0.13	0.15
Gold and silver mills:												
By amalgamation	20.9	22.8	21.5	20.9	20.7	31.5	.4	.4	.4	.4	.3	.5
By cyanidation	31.4	30.4	28.1	29.5	32.0	28.5	22.1	22.1	18.3	16.3	14.3	13.8
By chlorination	.4	.5	.5	.2	.2	.....	.....	.....	.....	.....	.....	.....
Total milling	52.7	53.7	50.1	50.6	53.9	60.0	22.5	22.5	18.7	16.7	14.6	14.3
Smelting[a]	22.1	23.6	24.9	23.6	22.5	14.4	77.3	77.3	81.1	83.1	85.3	85.55
Total[b]	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Both crude ore and concentrates.
[b] Philippine Islands and Porto Rico excluded.

The placers produced about 25.6 per cent of the total output of gold—an increase of 2 per cent. The dredges produced a little more gold in 1919 than in 1918, and the combined placer yield from hydraulic, drift, and other surface methods was about $994,000 less than in 1918. The decrease from placers was largely due to a decrease of 45,000 ounces in Alaska. The percentage of output of silver credited to the placers is insignificant.

In the mills the amalgamation process showed a large gain of 10.8 per cent of the total recovery of gold in 1919. This was due entirely to increases in Colorado, California, and Alaska, which produce ores more amenable to treatment by amalgamation. The percentage of gold recovered by cyanidation showed a decrease of 3.5 per cent, following an increase of 1.4 per cent in 1917 and of 2.5 per cent in 1918. Colorado, Nevada, Arizona, South Dakota, and Oregon ores yielded the larger part of the gold recovered by cyanidation and the decrease was due to much smaller recoveries by the cyanide process in Colorado. The chlorination process was not used in California in 1919.

GOLD AND SILVER PRODUCED AT MILLS, BY STATES.

A large quantity of concentrates from sulphide ores is now smelted, and the increased application of the flotation process has resulted in decreased yield of gold and silver from cyanidation, as nearly all such concentrates are shipped to smelters.

The smelters, which had for two years been producing a slightly greater proportion of gold and silver, are to be credited in 1919 with about 19 per cent of the total output of gold and 84.85 per cent of the silver. There was no appreciable decrease in the percentage of output of silver recovered at smelters, but that of gold decreased 3.9 per cent.

The bulk of the gold produced continues to come from the gold mills. As shown in the table the proportion of gold recovered by amalgamation and cyanidation has increased from 50.1 per cent in 1916 to 55.4 per cent in 1919.

Gold and silver produced at mills in 1919, by States.[a]

State or Territory.	Ore and tailings treated.	Bullion recovered.				Percentage of gold and silver from all sources.			
		Amalgamation.		Cyanidation.		Amalgamation.		Cyanidation.	
		Gold.	Silver.	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*	*Fine ounces.*				
Alaska	3,262,573	188,037	104,132	24,437	4,559	41.2	16.5	5.3	0.7
Arizona	213,573	319	111	124,625	117,530	.1	.....	57.2	2.2
California[b]	1,122,906	308,638	81,597	43,099	118,543	38.2	7.4	5.3	10.7
Colorado[c]	1,707,653	138,728	27,378	207,308	214,891	29.0	.5	43.3	3.7
Idaho	41,411	15,430	4,930	123	334	44.7	.1	.3	.....
Montana	110,944	2,522	758	32,825	84,183	2.3	.....	30.4	.7
Nevada	674,228	27,116	16,555	140,064	5,584,008	12.3	.2	63.8	81.4
New Mexico	74,167	11,681	2,452	6,309	318,851	36.8	.3	19.9	38.1
Oregon	62,480	257	201	18,206	47,494	.5	.2	38.5	42.7
South Dakota	1,329,481	146,816	41,595	86,018	72,662	62.4	35.7	36.6	62.4
Texas	54,467	.....	.....	.....	536,222	.....	.....	.....	99.6
Utah	14,614	204	24	2,316	64,449	.2	.....	2.2	.6
Washington	7	6	1	.....	.....	.....	.....	.....	.....
Wyoming	.....	2	1	.....	.....	50.0	.....	.....	.....
Appalachian States	3	5	58	.....	.....	1.4	.....	.....	.....
Total, 1919	8,668,507	839,761	279,793	685,330	7,163,726	31.5	.5	28.5	13.8
Value	.....	$17,359,400	$313,368	$14,167,028	$8,023,373	.....	.....	.....	.....
Total, 1918	8,524,496	678,359	216,670	1,047,186	9,736,605	20.7	.3	32.0	14.3
Value	.....	$14,022,925	$216,670	$21,647,256	$9,736,605	.....	.....	.....	.....

[a] Philippine Islands excluded.
[b] No gold and silver reported as recovered by chlorination in 1919. In 1918 value of gold so recovered was $119,173, silver $3,631.
[c] Part of ore amalgamated followed by cyanidation of new tailings. Total ore and new tailings cyanided 954,421 tons.

Figures corresponding to those in this table were collected and compiled for the entire United States by the Geological Survey for the first time in 1911, and comparison for nine years can therefore now be made. The total quantity of crude ore treated and old and new tailings re-treated in gold and silver mills was 8,668,507 short tons in 1919, against 8,524,496 tons in 1918, 11,076,211 tons in 1917, 11,393,838 tons in 1916, 11,878,287 tons in 1915, 9,849,085 tons in 1914, 9,401,856 tons in 1913, 9,677,360 tons in 1912, and 9,670,483 tons in 1911. In 1919 ores from Alaska, South Dakota, Colorado, California, and Nevada treated at gold and silver mills amounted to about 94 per cent of the total quantity.

The great bulk of the ore treated was milled in Alaska, Colorado, South Dakota, California, Nevada, and Arizona, and here the famous mines and mills of the Homestake, Mother Lode, Grass Valley, Treadwell, Cripple Creek, Tonopah, Goldfield, and San Francisco (Oatman) districts are especially noteworthy. Large numbers of smaller mills, however, mark the wide distribution of gold mining in these regions and in many other scattered districts.

The total yield of gold by amalgamation in the United States in 1919 was 839,761 fine ounces, against 678,359 fine ounces in 1918, 828,681 ounces in 1917, and 964,589 ounces in 1916.

Appreciable increases were shown in Colorado, Alaska, California, Idaho, and Nevada, and there were large decreases in South Dakota, Oregon, and Washington.

The silver produced by amalgamation came mainly from Alaska, California, South Dakota, Colorado, and Nevada, and consisted chiefly of silver alloyed with gold.

The output of gold by cyanidation was derived mainly from Colorado, Nevada, Arizona, South Dakota, California, and Montana. The principal decreases were in Colorado, 222,734 ounces; Nevada, 75,436 ounces; and South Dakota, 29,216 ounces.

Nevada led in yield of silver by cyanidation and was followed by Texas, New Mexico, and Colorado. The most notable losses were in Arizona, 40,495 ounces; Colorado, 112,835 ounces; and Nevada, 2,494,681 ounces. The only gains of any size were 57,673 ounces in California, 56,737 ounces in New Mexico, and 60,289 ounces in Utah.

The quantity of gold recovered from ore treated by amalgamation increased 161,402 ounces in 1919, and that recovered from ores cyanided decreased 361,856 ounces.

Of the gold-producing States whose output is chiefly derived from milling ores, Alaska, California, New Mexico, and South Dakota still yield more gold by amalgamation than by cyanidation, but cyanidation produces more gold than amalgamation in Arizona, Colorado, Montana, Nevada, and Oregon, and it produces much more silver in Arizona, California, Colorado, Montana, Nevada, New Mexico, Oregon, South Dakota, and Texas. Only in Alaska and Idaho did the recovery of silver by amalgamation exceed that by cyanidation. Altogether amalgamation produced gold and silver valued at $17,672,768 from milling ores in 1919, against $22,190,401 produced by cyanidation from such ores in that year.

Of the total output of gold from all sources in 1919, amalgamation produced 41.2 per cent in Alaska, 38.2 per cent in California, 36.8 per cent in New Mexico, and 62.4 per cent in South Dakota; and cyanidation produced 57.2 per cent in Arizona, 43.3 per cent in Colorado, 30.4 per cent in Montana, 63.8 per cent in Nevada, 19.9 per cent in New Mexico, and 36.6 per cent in South Dakota.

Of the total output of silver from all sources in 1919, amalgamation produced 35.7 per cent in South Dakota and 16.5 per cent in Alaska, and cyanidation produced 81.4 per cent in Nevada, 38.1 per cent in New Mexico, 42.7 per cent in Oregon, 62.4 per cent in South Dakota, and 99.6 per cent in Texas.

QUICKSILVER AND POTASSIUM AND SODIUM CYANIDE CONSUMED IN CERTAIN STATES.

For details of the consumption of quicksilver in the amalgamation milling process and of potassium cyanide and sodium cyanide in the cyanidation process the reader is referred to the mines reports of the several Western States. Data as to consumption of these supplies are not yet furnished by a sufficient number of mining and milling companies to justify tabulation for the entire United States. It has been estimated by H. D. McCaskey that the consumption of quicksilver in the amalgamation process in the United States (including Alaska) for the period 1911 to 1917, inclusive, varied between 90,000 and 100,000 pounds annually. In 1918 and 1919 the consumption probably did not exceed 75,000 pounds, as the gold recovered from placers and by amalgamation was less than in 1916 and 1917. The consumption at mills treating ore and by dredging and other methods of placer mining is given in the separate chapters on quicksilver in 1917, 1918, and 1919 in Mineral Resources.

The following tables were compiled by V. C. Heikes, of the United States Geological Survey.

Quicksilver consumed in certain Western States, 1911–1919.

State and year.	Number of mills using quicksilver.	Ore and tailings treated.	Total quicksilver.[a]	Quicksilver consumed (average per ounce of gold and silver bullion).
Arizona:		*Short tons.*	*Pounds.*	*Pound.*
1911	26	46,833	1,362.00	0.086
1912	40	28,028	1,414.30	.098
1913	18	36,338	2,912.68	.158
1914	22	44,808	1,802.00	.116
1915	32	34,360	547.00	.063
1916	13	17,568	645.00	.040
1917	9	21,100	205.00	.057
1918	7	1,389	17.00	.012
1919	6	2,374	33.00	.077
Idaho:				
1911	35	72,210	1,648.00	.057
1912	43	34,609	700.00	.020
1913	40	28,258	254.00	.019
1914	29	25,877	598.00	.042
1915	36	46,423	1,040.00	.027
1916	36	66,304	1,183.00	.039
1917	27	63,884	1,035.00	.032
1918	22	31,263	953.00	.057
1919	12	40,504	828.00	.0406
Montana:				
1911	24	61,767	898.00	.031
1912	17	48,837	783.59	.047
1913	23	14,508	289.57	.077
1914	18	29,983	408.00	.074
1915	24	28,504	371.00	.051
1916	18	18,959	206.00	.026
1917	13	8,925	167.00	.040
1918	13	6,492	99.00	.053
1919	17	13,142	178.00	.054
Nevada:				
1911	56	781,463	4,753.00	.012
1912	49	388,714	6,636.73	.044
1913	39	360,579	5,054.73	.051
1914	42	250,408	6,826.00	.063
1915	47	211,729	4,367.00	.038
1916	36	131,891	2,111.00	.034
1917	32	67,359	839.00	.020
1918	34	54,048	675.00	.017
1919	21	60,038	1,149.00	.026
Utah:				
1911	6	5,020	105.00	.058
1912	4	588	27.70	.145
1913	3	1,157	71.81	.107
1914	2	533	20.00	.108
1915	3	1,399	30.00	.020
1916	4	703	15.00	.039
1917	2	190	5.00	.030
1918	2	112	2.00	.018
1919				
Washington:				
1911	5	11,846	526.00	.197
1912	9	4,609	121.00	.043
1913	9	768	43.82	.038
1914	5	2,146	43.00	.039
1915	3	1,286	28.00	.031
1916	5	11,495	317.00	.027
1917	4	10,976	185.00	.026
1918	1	960	20.00	.038
1919				

State.	1912	1913	1914	1915	1916	1917	1918	1919
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Arizona	1,414.30	2,912.68	1,802	547	645	205	17	33
Idaho	700.00	254.00	598	1,040	1,183	1,035	953	828
Montana	783.59	289.57	408	371	206	167	99	178
Nevada	6,636.73	5,054.73	6,826	4,367	2,111	839	675	1,149
Utah	27.70	71.81	20	30	15	5	2	.....
Washington	121.00	43.82	43	28	317	185	20	.....
	9,683.32	8,626.61	9,697	6,383	4,477	2,436	1,766	2,188

[a] Partly estimated.

Quicksilver consumed in Colorado in 1919 amounted to 4,540 pounds, in New Mexico to 300 pounds, and in South Dakota to 9,000 pounds.

The Mining and Scientific Press, April 6, 1918, contains an article on "The loss of quicksilver in gold mills," by W. J. Sharwood. Tables are given showing available data on the consumption of mercury in stamp mills on a basis of troy ounces of mercury used per short ton of ore for various mills in the United States, Mexico, Canada, South Africa, Chosen (Korea), Celebes, and Australasia.

Potassium and sodium cyanides consumed in certain Western States, 1911–1919.

State and year.	Number of mills using cyanidation process.	Ore and tailings treated.	Total consumption of cyanide.[a]	Cyanide consumed.	
				Average per ton of ore and tailings.	Average per ounce of gold and silver.
Arizona:		*Short tons.*	*Pounds.*	*Pounds.*	*Pounds.*
1911	9	152,815	115,877	0.758	0.919
1912	9	202,285	129,987	.642	.973
1913	11	208,591	189,291	.907	1.138
1914	13	294,827	264,969	.900	.369
1915	17	267,639	227,142	.850	.275
1916	9	276,623	216,841	.780	.300
1917	10	227,648	157,961	.69	.430
1918	10	221,508	157,829	.71	.53
1919	8	211,199	117,489	.56	.49
Idaho:					
1911	10	64,510	181,808	2.818	4.300
1912	5	54,477	161,156	2.958	3.360
1913	6	37,303	94,475	2.533	3.400
1914	10	12,094	32,529	1.800	2.530
1915	10	4,676	6,619	1.410	.440
1916	8	3,469	4,631	1.33	.38
1917	4	3,793	4,996	1.30	.45
1918	4	9,582	15,600	1.63	4.45
1919	3	907	950	1.05	2.07
Montana:					
1911	27	203,912	91,657	.449	.610
1912	21	184,487	93,344	.506	.913
1913	24	170,348	116,422	.683	.958
1914	13	192,235	151,738	.789	.921
1915	18	330,140	163,380	.494	.449
1916	18	381,560	203,554	.53	.69
1917	15	328,685	158,215	.48	.53
1918	14	190,119	83,542	.44	.53
1919	11	97,802	64,900	.66	.55
Nevada:					
1911	41	1,083,883	2,352,961	2.170	.313
1912	37	1,179,365	2,618,424	2.220	.252
1913	29	1,326,793	2,798,224	2.109	.228
1914	36	1,240,337	3,217,886	2.365	.258
1915	37	1,479,898	3,063,606	2.070	.239
1916	33	1,367,249	2,320,328	1.70	.20
1917	32	1,203,665	1,925,168	1.60	.20
1918	33	1,220,879	1,765,010	1.45	.21
1919	30	614,190	1,043,111	1.70	.182
Utah:					
1911	6	268,691	205,041	.763	1.450
1912	6	170,809	203,721	1.193	2.380
1913	6	81,940	70,238	.857	.956
1914	4	17,113	7,396	.432	.607
1915	3	12,064	5,356	.440	.830
1916	2	720	1,200	1.67	4.48
1917					
1918	1	900	2,700	3.00	.63
1919	1	14,571	37,844	2.597	.566
Washington:					
1911	3	17,381	9,700	.544	2.605
1912	4	16,703	36,517	2.186	.993
1913	2	20,410	32,090	1.572	.993
1914	2	22,387	48,820	2.180	.999
1915	4	1,746	4,600	2.600	.916
1916	1	1,207	2,380	1.97	3.12
1917					
1918					
1919					

[a] Partly estimated.

Sodium cyanide consumed in certain Western States, 1915–1919, in pounds.[a]

State.	1915	1916	1917	1918	1919
Arizona	226,427	216,841	157,381	157,204	99,605
Colorado	1,088,592	1,082,617	746,428	779,741	582,547
Idaho	3,725	700	3,728	15,600	950
Montana	162,377	190,249	158,215	83,542	64,903
Nevada	3,050,092	2,179,995	1,925,038	1,765,010	992,840
New Mexico	216,709	176,525	123,500	79,065	108,805
South Dakota	458,300	419,210	384,938	370,218	284,653
Texas	.....	45,100	37,000	63,130	38,700
Utah	5,320	.....	37,000	2,700	37,844
Washington	3,400	2,380	.....	.....	.....
	5,214,942	4,313,617	3,573,228	3,316,210	2,210,844

[a] The consumption of potassium cyanide was 205,719 pounds in 1915, 185,764 pounds in 1916, 137,658 pounds in 1917, 625 pounds in 1918, and 68,155 pounds in 1919 (17,884 pounds at mills in Arizona and 50,271 pounds at mills in Nevada).

It has not been possible to obtain a complete report showing the total consumption of potassium cyanide and sodium cyanide used in the recovery of gold and silver in the United States in 1919. If the quantity used in California, Alaska, and Oregon is added to the 2,210,844 pounds reported to have been used in other Western States, the estimated total consumption was probably about 3,000,000 pounds.

The quantity of cyanide used per ton of ore or tailings treated and the quantity of gold and silver recovered per pound of cyanide show considerable variations. These variations are doubtless due in part to greater efficiency in large milling plants in some of the States, but are caused mainly by differences in the character and the metal content of the ores treated.

ACKNOWLEDGMENTS.

To those engaged in the mining and metallurgic industries, to merchants, bankers, and transportation officials of the United States and Alaska, to the Bureau of the Mint, the Post Office Department, and the Bureau of Foreign and Domestic Commerce of the Department of Commerce, and to other officials, public and private, who have cooperated with the United States Geological Survey by furnishing information on the production of gold and silver, acknowledgment is gratefully made. To the authors of the Survey mines reports on the production of gold, silver, copper, lead, and zinc in the Eastern, Central, and Western States and in Alaska, Messrs. C. N. Gerry, V. C. Heikes, Charles W. Henderson, G. C. Martin, and Charles G. Yale, the writer is especially indebted.

COBALT.

By Frank L. Hess.

PRODUCTION.

In 1919 cobalt ores were mined in Idaho and Missouri. In Idaho the Haynes Stellite Co. spent a considerable sum of money in development work but produced no ore. In Missouri the Missouri Cobalt Co. shipped cobalt oxide recovered from ore mined at its property near Fredericktown. In 1918 cobalt ores were mined only in Idaho, where the Haynes Stellite Co. produced 55 tons of concentrates, carrying 17.74 per cent of cobalt (19,514 pounds), from 4,000 tons of ore.

The cobalt and nickel deposits in Missouri are well described by H. A. Buehler,[1] State geologist of Missouri, in his report for 1919, which was quoted in Mineral Resources for 1918, Part I, page 793.

IMPORTS.

Most of the cobalt used in this country is imported from Canada, where it is obtained as a by-product from silver ores mined in the cobalt district.

Cobalt, and cobalt ore, and zaffer, and cobalt oxide imported and entered for immediate consumption in the United States, 1915–1919.

Year.	Cobalt, and cobalt ore, and zaffer.		Cobalt, oxide of.		Total.	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.	Quantity (pounds).	Value.
1915	53,375	$70,283	154,672	$148,828	208,047	$219,111
1916	136,770	175,236	206,639	192,009	343,409	367,245
1917	223,794	369,950	276,406	275,821	500,200	645,771
1918	504,391	628,099	208,596	291,699	712,987	919,798
1919	77,556	144,282	131,424	184,751	208,980	329,033

[1] Biennial report of the State geologist, Missouri Bur. Geology and Mines, pp. 55-56, 1919.

MOLYBDENUM.

By Frank L. Hess.

PRODUCTION.

During 1919 six companies did more or less work on molybdenite deposits in Maine, Colorado, Utah, and New Mexico, but the market was so poor that the two large companies, the Climax Molybdenum Co., at Climax, Colo., and the Primos Exploration Co., at Camp Urad, Clear Creek County, Colo., closed down on April 1 and July 1, respectively. The R. & S. Molybdenum Mines Co., at Questa, Taos County, N. Mex., continued development and experimental work throughout the year; the Maine Metals Co. mined and concentrated a little ore near Cooper, Me.; the Pennsylvania Molybdenum Mines Co. mined considerable ore and made some concentrate on the Bon Ton group of claims, near Pitkin, Colo.; and the Stimpson Equipment Co., of Salt Lake City, experimented with ore from Alta, Utah.

The production of ore during the year as reported to the Bureau of the Census and the United States Geological Survey amounted to about 83,700 tons, from which was obtained 971 tons of concentrates carrying 198.6 tons of molybdenum, of which concentrates carrying 49 tons of molybdenum were sold, and 108.7 tons carrying 49.6 tons of molybdenum were on hand at the end of the year.

Molybdenum in ore and concentrates produced and sold in the United States, 1914–1919.

Year.	Quantity sold (pounds).	Value.	Year.	Quantity sold (pounds).	Value.
1914	1,297	$1,297	1917	350,200	$495,350
1915	181,769	114,866	1918	861,637	1,253,700
1916	206,740	205,000	1919	297,926	341,814

World's output of molybdenum concentrates in terms of the contained molybdenum, 1916–1919.

[M=molybdenite; W=wulfenite.]

Country.	Ore mineral.	1916		1917		1918		1919	
		Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.	Quantity (metric tons).	Value.
Australia	M	70.39	$314,800	102.05	$456,273	111.8	$500,000	140.87	$414,391
Austria	W	(a)	(a)	(a)	(a)	(a)	(a)	.....	.....
Bolivia	M	5.17	7,663	(a)	(a)	(a)	(a)	.....	.....
Canada	M	42.5	156,461	78.5	288,705	102.8	434,528	30.93	84,228
Chile	M	.8	.....	20.1	9,836	.....	.....	.....	.....
China	M	2.7	1,700	2.4	1,600	1.08	3,689	.....	.....
Chosen	M	3.2	12,463	59.2	19,034	10.7	25,884	.....	.....
Germany	M	(a)	(a)	(a)	(a)	(a)	(a)	.....	.....
India	M	.4	983	.7	3,050	.09	551	.09	492
Italy	M	.....	.....	.2	(a)	.....	.....	.....	.....
Japan	M	18.3	31,177	12.06	30,124	[b] 70.3	12,746	.....	.....
Norway	M	73.1	(a)	82.1	533.333	84.9	1,248,804	.....	.....
Peru	M	3.08	14,120	3.8	20,970	1.3	7,445	2.5	12,318
Sweden	M	.3	1,194	20.3	40,000	25.1	463,629	.....	.....
United States	M, W	93.8	205,000	158.8	495,350	390.8	1,253,700	135.1	341,814

[a] Figures not available.

[b] 54.7 metric tons coarse ore of low grade.

IMPORTS.

No record of imports of molybdenum ores was kept by the Bureau of Foreign and Domestic Commerce before July 1, 1918. During the last six months of 1918, 140,222 pounds of molybdenum ore, valued at $123,924, was imported; in 1919 the imports amounted to 106,743 pounds, valued at $77,572.

NICKEL.

By Frank L. Hess.

PRODUCTION.

Prior to 1919 the United States produced no nickel from domestic materials except as a by-product of copper refining, as shown in the following table. In 1919, however, nickel was also produced from complex sulphides mined on the property of the Missouri Cobalt Co., near Fredericktown, Mo. (See p. 711.) Large quantities of nickel matte imported from Canada and smaller quantities of matte from New Caledonian ore are, however, refined in the United States:

Nickel content of nickel salts and metallic nickel produced in the United States as a by-product in the electrolytic refining of copper, 1915–1919, and from cobalt ores in 1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1915	822	$538,222	1918	441	$401,000
1916	918	671,192	1919 [a]	511	434,485
1917	402	331,556			

[a] Including nickel produced from cobalt ores mined in Missouri.

IMPORTS.

Nickel imported for consumption in the United States, 1915–1919.

Year.	Nickel, nickel ore and matte, nickel oxide, and alloys of nickel with copper, etc.		Value of manufactured articles of nickel and nickel sheets and strips.	Total value.
	Quantity (pounds).	Value.		
1915	56,599,381	$7,629,686	$6,458	$7,636,144
1916	72,649,377	9,899,340	25,880	9,925,220
1917	75,526,767	9,617,163	45,248	9,662,411
1918	73,207,147	11,520,775	115,243	11,636,018
1919	36,562,388	8,334,135	90,451	8,424,586

Nickel imported for consumption in the United States, 1918 and 1919, by forms.

Form.	1918		1919	
	Quantity (pounds).	Value.	Quantity (pounds).	Value.
Nickel ore and matte (nickel content)	[a] 34,875,878	[a] $4,576,981	[b]	[b]
Nickel ore (nickel content)	[c]	[c]	10,431,602	$1,959,729
Nickel matte (nickel content)	[d] 38,317,327	[d] 6,940,565	18,871,626	3,820,651
Nickel, alloys, pig, bars, etc	40	8	7,258,082	2,553,431
Nickel oxide	13,902	3,221	1,078	324
Nickel sheets and strips	[e]	[e] 2,731	10,152	4,889
	[f] 8,612	[f] 4,150		
All other manufactures	[e]	[e] 84,138	87,527	85,562
	[f] 10,495	[f] 24,224		
	73,226,254	11,636,018	36,660,067	8,424,586

[a] Figures cover six months, January to June. Separately classified beginning with July.
[b] Separately classified during 1919.
[c] Included under "Nickel ore and matte" for first six months. No ore imported July to December.
[d] Figures cover six months, July to December. Included under "Nickel ore and matte" prior to July.
[e] Quantity not shown. Value covers six months, January to June.
[f] Figures cover six months, July to December.

Nickel ore and matte imported into the United States, 1918 and 1919, by countries.

[General imports.]

Country.	Nickel ore and matte.			Manufactures.[a]	
	Quantity (short tons).	Nickel content (pounds).	Value.	Quantity (pounds).	Value.
1918.					
Australia	2,339	2,027,850	$433,878		
Canada	63,835	70,645,034	10,974,325	9,518	$4,441
Chile	1	91	44		
England				9,328	5,517
France				86	411
Japan				4,870	6,671
Oceania:					
British (other than Australia)	489	409,023	85,934		
French	112	111,207	23,365		
Switzerland				1,172	12,339
	66,776	73,193,205	11,517,546	24,974	29,379
1919.					
Australia	3,008	3,716,293	$760,887		
Canada	22,760	25,503,767	4,997,650	7,303,679	$2,580,695
China				3	2
Denmark				4	17
England				23,607	16,246
France				1,188	5,055
Germany				68	271
Japan				23,777	13,167
Netherlands				11	172
Oceania, French	56	83,168	21,843		
Spain				10	10
Switzerland				3,414	28,247
	25,824	29,303,228	5,780,380	7,355,761	2,643,882

[a] Figures for 1918 cover six months, July to December. Not separately classified by countries prior to July.

EXPORTS.

Nickel, nickel oxide, and matte exported from the United States, 1915–1919.

Year	Quantity (pounds).	Value.	Year.	Quantity (pounds).	Value.
1915	26,418,550	$10,128,514	1918	17,469,500	$6,927,041
1916	33,404,011	12,952,493	1919	3,810,656	1,697,544
1917	21,992,820	8,936,620			

TANTALUM.

By Frank L. Hess.

PRODUCTION.

For several years prior to 1918 there had been no market for tantalum or columbium minerals, and they had therefore not been produced. There had, however, been a continuously active interest in research in all lines of metallurgy, and tantalum, as its name suggests, had tantalized the investigator by its attractive qualities, such as resistance to the action of most acids and many other chemicals and of the air, high tensile strength, malleability, and high melting point, the rarity of its minerals, its almost invariable association with columbium, titanium, and other metals from which it is separated only with the greatest difficulty, and the difficulty of its reduction.

In 1918 the demand for tantalum and columbium salts for experiments became large enough to allow A. T. Roos, of Deadwood, S. Dak., to market 4,500 pounds of columbite, valued at $2,250. The columbite, which carried about 50 per cent of tantalum oxide (Ta_2O_5), was taken from the pegmatite dike on the Bob Ingersoll claim (a few miles west of Keystone, S. Dak., on the road to Hill City), and from the Etta and other claims. In 1919 only 300 pounds, valued at $90, was shipped, but orders for several hundred pounds were received and larger shipments were expected to be made early in 1920.

No tantalum or "tantalum steel-hardening ores" were imported into the United States in 1919, and no separate record of exports is kept.

TITANIUM.

By Frank L. Hess.

PRODUCTION.

Rutile, titanium dioxide (TiO_2), and ilmenite, titanium-iron oxide ($TiFeO_3$), were produced in this country in 1919 by the American Rutile Co., at Roseland, Nelson County, Va. The company produced 102 short tons of rutile concentrates, carrying 94 to 96 per cent of TiO_2, valued at $20,400, and 106 tons of ilmenite concentrates, carrying 48 to 50 per cent of TiO_2, valued at $2,120. No production was made after August 1, 1919, as the company suspended operations for the erection of a new plant.

Buckman & Pritchard (Inc.) produced a considerable quantity of ilmenite from the beach sands 4 miles south of Pablo Beach, Fla. The material was shipped to the Titanium Alloy Manufacturing Co., at Niagara Falls, N. Y., which controls the Florida company and does not wish to have the figures of production made known. Some rutile and zircon were also separated from the sands.

In 1918, against the advice of representatives of the Bureau of Mines and of the United States Geological Survey, the Government gave a contract to Buckman & Pritchard (Inc.) under which the firm was to furnish 410 tons of rutile at $90 a short ton for concentrate carrying 94 per cent of TiO_2, to be used in manufacturing titanium tetrachloride for making "smoke screens" for covering the movements of troops and vessels. The representatives of the two bureaus reported that it was unlikely that the firm could produce rutile in large quantities in less than six months, and their estimate proved conservative, for no rutile had been furnished at the time the armistice was signed. The Government advanced $11,000 in May, 1918, on the contract. An expensive plant for the electrostatic separation of zircon and rutile, with other machinery, was installed, and some rutile was separated late in 1918 and in 1919; it was sold to the General Electric Co., as the United States Government was no longer in the market.

In 1919, under the act approved March 2, 1919, Buckman & Pritchard (Inc.) applied for a large sum to cover their loss on the contract. A hearing was held before the Board of Contract Adjustment, and later the firm was given an award from which was to be deducted the $11,000 advanced, with interest from the date of its receipt to the date of the award.

Titanium minerals produced in the United States, 1915–1919.

Year.	Rutile concentrates.		Ilmenite concentrates.		Total value.
	Quantity (short tons).	Percentage of TiO_2.	Quantity (short tons).	Percentage of TiO_2.	
1915	250	94–96	300	55	$27,500
1916	110	95	95	55	18,400
1917	206	93	1,339	53–55	45,637
1918	261	95	1,644	53–55	57,750
1919[a]	102	94–96	106	48–50	22,520

[a] Virginia production only; information regarding Florida not available for publication.

IMPORTS AND EXPORTS.

No titanium or "titanium steel-hardening ores" were imported during 1919. The imports of such steel-hardening ores during the last six months of 1918 were 1,606 pounds, valued at $221. No separate record of similar imports was kept prior to July, 1918.

No separate record of exports of titanium, "titanium steel-hardening ores," or ferrotitanium is kept.

TUNGSTEN.

By Frank L. Hess.

GENERAL CONDITIONS.

The decline in the output of tungsten in 1919 from that of 1918 was as marked as was to have been expected after the world-wide overproduction of the late war period and the fall in prices that followed the signing of the armistice. In 1918 the output was equivalent to 5,061 short tons of concentrates carrying 60 per cent of tungsten trioxide (WO_3), valued at $7,049,300, but in 1919 it was only 403 tons carrying 531,012 pounds of WO_3, equivalent to 442 tons carrying 60 per cent of WO_3, of which 327 tons was marketed for $353,900, and the remainder was in stock at the end of the year.

At the beginning of the year wolframite ore of high quality, carrying 65 per cent or more of WO_3, could be readily bought at $12 a unit, although the published quotations ranged about $15 a unit. At the end of the year similar concentrates could be bought for $6 a unit or less. Published quotations ranged from $6.50 for Chinese wolframite to $15 for domestic scheelite, but the higher prices could be described only as hopeful quotations, for Chinese wolframite dominated the world's markets. At the beginning of the year tool-steel makers still looked forward to a large consumption of tungsten concentrates during the year, and the public in general refused to credit the serious straits to which the world had been brought by the great war, so that there was a natural attempt to uphold prices and many were hurt financially by the sudden cessation of demand and the drop in prices.

Stocks of concentrates in the United States and England and apparently in France were very large, equal to two or three years' supply, and the Chinese placers continued to be worked even with the falling prices, although some of the operators failed from not foreseeing the inevitable cheapening of ore. This ore and ore mined more cheaply kept coming in, so that stocks, which amounted to more than 6,000 tons at the beginning of the year, were larger than ever at its end. In October, 1915, the British Government took over the production of all tungsten ores within the British Empire, buying concentrates carrying 70 per cent of WO_3 at 50 shillings and later at 60 shillings a long-ton unit c. i. f. London. At the same time the Government agreed to take the concentrates at the same rate for six months after the end of the war. In 1919, owing to the fall in world prices, for the first time after the beginning of the war, the price in British territory was as high as the world market price, and production continued. On April 4, 1919, the Straits Settlements Government Gazette published a cablegram stating that "in view of

the fact that stocks of tungsten ores and molybdenite now in the United Kingdom and on the way there are more than sufficient to meet the requirements of the United Kingdom for at least 18 months, the minister of munitions has decided to terminate existing purchase arrangements and will not accept delivery of tungsten ore or molybdenite loaded from British oversea ports on ocean steamer after April 30, 1919." He further expressed the hope that producers in their own interests would take immediate steps to reduce the production of the minerals.[1] The date was later changed to May 31, and the Government agreed to pay compensation upon claims for ore which would have been produced from June 1 to December 15, 1919, inclusive, the compensation to be the difference between the guaranteed price of $15.79 per picul (133⅓ pounds) and the then quoted price of $7.29 per picul, but the compensation was to apply only to ores containing not less than 65 per cent of WO_3.[2]

In Australia the Commonwealth Government agreed to take all ore produced at the former fixed price until December 31, 1919.[3] But prices when compared with those in this country had been very low all through the war. In 1914 the price was 30 to 33s. per long-ton unit; 1915, 35s. c. i. f. London; 1916, 55s. c. i. f. London; 1917 and 1918, 52s. 6d. at the producing center.[4] Taking 20¼ cents as the value of the shilling in 1914, and 16.5 cents as a rough average value of the shilling in United States currency during the war, these prices were equivalent in 1914 to $5.42 to $5.97 a short-ton unit; 1915, $5.16 c. i. f. London; 1916, $8.12 c. i. f. London; 1917 and 1918, $7.72 at producing center, for concentrates carrying 65 per cent or more of WO_3, and prices in other producing centers of the British Empire were on the same basis. In the United States during the same years the prices actually received per short-ton unit for concentrates carrying 60 per cent or more of WO_3, averaged from all sales of domestic ores made, were: 1914, $7.32; 1915, $29.30; 1916, $33.98; 1917, $18.40; $1918, $23.24.

In China there was a short period of uncertainty while the various persons engaged in mining and handling tungsten concentrates made up their minds that high prices would probably not return. On February 7, 1919, George E. Anderson,[5] American consul general at Hongkong, described the situation thus:

> There has been almost a complete cessation of activity in the export of wolfram from Hongkong since the fall in prices in the United States during the closing months of the year, but the record of the trade for the year 1918 was remarkable and illustrates the extraordinary nature of the south China tungsten ore fields. The shipments of this ore from Hongkong commenced in the fall of 1917 [shipments of Chinese ore had, however, been made from China since 1914.—F. L. H.], and during the whole of that year only 512,000 pounds, or 256 short tons, valued at only $93,081 gold, or $364 gold per short ton, were shipped to the United States. In 1918 the total shipments amounted to 10,330,584 pounds, or 5,165 short tons, valued at $4,808,358, or $931 per ton. As a matter of fact, most of the shipments in 1918 were made at a value of substantially $1,000 gold per short ton. During both years about the same amounts and at about the same values were shipped to Europe, prices to Europe tending lower at times because of the fixing of the price for the ore by the British Government and the control of the export exercised through the government of Hongkong.

[1] Gunsaulus, E. N., American consul general, dispatch of Apr. 7, 1919.
[2] Dispatch of July 23, 1919.
[3] Acting Attorney General Groom, quoted in Ind. Australian and Min. Standard, vol. 62, p. 58, 1919.
[4] Min. Jour. (London) vol. 126, p. 545, 1919.
[5] Manuscript report to Department of State.

The most notable feature of the trade was the fact that the best ore fields were only coming into production at the time the trade, by reason of an overstocking in the United States and Europe, fell off. In July of the past year a large field on the border of Kwangtung and Kwangsi Provinces was located and active development commenced. Aside from the actual production of other fields in Kwangtung Province, the possible production of this new field unquestionably establishes south China as the chief source of the world's supply of tungsten in its various forms in the future, for at the height of shipments in 1918 these fields, including the rich new deposits, were producing something like 1,200 tons per month. The possibilities of its full development on an economical and profitable basis is indicated by the fact that the first shipments of the ore from the south China field at all were made at about one-third the rate obtainable under later war conditions. The new field is centered very largely around Sai Wah Shan or Sai Wah mountain, which is in the vicinity of the city of Nannan-fu, in Kwangsi Province, not very far from the Kwangtung Province border. The ore is carried by coolies over a route requiring from four to five days' travel, and thence is carried by boat down a small river to Shui-chow which is the head of railroad traffic on the so-called Canton-Hankow Railroad. Considerable ore also comes from districts rather to the east, which is carried to the East River at Ting Nam and comes into the market by rail from Low Lung. Most of the ore mined in this richer district is from pockets [placers] in public or semipublic land—that is, land owned by the several neighboring villages. The ore is purchased in small lots by middlemen, and until the latter can know something of what prices in the immediate future are to be they can not safely buy the lots of ore available. On the other hand, it is not always possible to demonstrate to villagers what their ore really is worth.

During the opening weeks of the new year export has been substantially at a standstill because of a lack of orders at prices comparable with those obtained during most of the past year from consuming districts. There is no question but that the ore can be mined and shipped at a good profit at present prices, but until owners and operators of the mines understand what the normal or post-war level of prices may be, it is likely that little mining will be done. Exports of the ore from Hongkong to the United States during January amounted to only 90,100 pounds, valued at $35,061 gold, or $740 gold per short ton.

It should be understood that all of the above values, even the declared values, are more or less tentative and the actual value of ore usually can not be known until it has been analyzed in the United States or other country where it is properly reduced. Usually the actual cost of good grade ore at the surface mine, whence most of it comes, is something like $20 local currency per picul of 133⅓ pounds, or, at average exchange for the past year, something like $250 gold per short ton. By the time the coolie transport for four or five days, water and rail transportation, and the various taxes and "squeezes" of Chinese officials are paid, however, the cost is immensely increased.

"Squeezes" and other charges apparently fell with world prices, for Chinese exports to the United States continued, and the total received from China was 6,213 short tons (3,403 tons from Hongkong) of concentrates, valued at $3,873,550, against 5,979 tons (3,595 tons from Hongkong), valued at $5,579,682, in 1918. The concentrates probably averaged more than 65 per cent WO_3.

From other sources also, particularly from Bolivia, Japan (including Chosen), and Peru, large quantities of concentrates flowed to this country, in all 9,408 short tons, valued at $6,261,190, probably carrying somewhat more than 65 per cent of WO_3 and equivalent to 10,200 tons of concentrates carrying 60 per cent of WO_3.

The tool-steel makers of the country used great quantities of scrap in making new steel, large stocks of tungsten concentrates were on hand, and even without the large imports it would have been impossible to market American tungsten ores. Like others, tungsten miners had not looked for so heavy a slump in the market price and were badly hurt by it.

The demand for a high tariff on tungsten ore and products begun in 1918 was continued by miners and by importers with stocks of ore in this country, and a bill imposing a tariff of $10 per unit passed the House but was still before the Senate at the end of the year.

It was known that certain persons and companies had been encouraged either to enlarge their scale of operations or to embark on new enterprises to mine minerals, especially pyrite, chromite, manganese, and tungsten ore needed by the Government during the war, and an act was approved March 2, 1919, authorizing the organization of the War Minerals Relief Commission to adjudicate their claims.

PRODUCTION.

The small production of tungsten ore made in the United States during 1919 was divided between Arizona, California, Colorado, and South Dakota. In Arizona the Yucca Tungsten Mining Co., in the north end of the Hualpai Mountains, mined wolframite with a little scheelite, and a number of prospectors took out a little scheelite in the Huachuca Mountains. In Colorado the Vasco Mining Co. did some mining and the Long Chance Mining Co. did some work cleaning up odds and ends of ore. In California the Tungsten Mines Co. made some scheelite concentrates near Bishop, and in South Dakota the Homestake Mining Co. concentrated some wolframite at Lead.

Concentrated tungsten ores (carrying 60 per cent of tungsten trioxide) produced and sold in the United States, 1900–1919,[a] and selling price per unit.

Year.	Quantity (short tons).	Value.	Average selling price per unit.	Year.	Quantity (short tons).	Value.	Average selling price per unit.
1900	46	$11,040	$4.00	1910	1,821	$832,992	$7.68
1901	179	27,720	2.58	1911	1,139	407,985	5.97
1902	184	34,040	3.08	1912	1,330	502,158	6.27
1903	292	43,639	2.49	1913	1,537	672,118	7.24
1904	740	184,000	4.12	1914	990	435,000	7.32
1905	803	268,676	5.57	1915	2,332	4,100,000	29.30
1906	928	348,867	6.26	1916	5,923	12,074,000	33.98
1907	1,640	890,048	9.04	1917	6,144	6,783,000	18.40
1908	671	229,955	5.71	1918	5,061	7,049,300	23.24
1909	1,619	614,370	6.32	1919	327	353,900	18.02

[a] The tungsten content of the ores produced in 1901–1905, inclusive, is unknown but was probably not far from 60 per cent of WO_3 and was likely a little more rather than less.

From this table it will be seen that for the first 10 years of production the mean of the average selling prices of tungsten concentrates was $4.92 a unit, and that for the five years next preceding the great war it was $6.90; for the whole 15 years of production before the war the average was $5.58.

The average price for 1919 is so high only because some ore was sold on high priced contracts made before the great drop in prices.

SUPPLY.

Supplies of tungsten ores in the United States, 1915–1919, in short tons.

Year.	Production.	Imports for consumption.			Exports.[a]		Apparent consumption, plus stocks on hand.[b]
		Ore.	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.[c]	Tungsten and ferrotungsten.	Estimated equivalent in ore carrying 60 per cent of tungsten trioxide.	
1915	2,332	1,776	8	1,942	.....	.....	4,274
1916	5,923	3,973	43	4,401	287	580	9,744
1917	6,144	4,876	1	5,284	1,162	2,420	9,008
1918	5,061	11,750	.....	12,729	616	1,265	16,525
1919	327	9,408	198	10,638	19	42	[d] 10,923

[a] No record of tungsten ore exported is at hand, although it is known that some has been shipped abroad.
[b] Production plus imports minus estimated equivalent in ore of the exports of tungsten and ferrotungsten. The apparent consumption is at best only an approximation.
[c] These items include the ore (considered as carrying 65 per cent of tungsten trioxide) and the tungsten and ferrotungsten (considered as equivalent to 2½ times their weight in ore carrying 60 per cent of tungsten trioxide). Chinese ore imported has been considered as 67.5 per cent of tungsten trioxide.
[d] Large stocks were on hand at the end of the year, probably equivalent to at least 8,000 short tons of concentrates carrying 60 per cent of WO_3.

IMPORTS AND EXPORTS.

Tungsten-bearing ores imported into the United States, 1918–19, by countries.[a]

[General imports.]

1918			1919		
Country.	Quantity (short tons).	Value.	Country.	Quantity (short tons).	Value.
Argentina	536	$730,722	Argentina	145	$111,489
Bolivia	88	122,357	Bolivia	545	213,793
Brazil	3	4,177	Canada	20	12,750
Canada	56	115,863	Chile	985	685,414
Chile	1,250	1,209,864	China	2,810	1,624,539
China	2,385	2,068,636	Chosen	52	58,375
Colombia	56	65,124	Colombia	1	1,312
Costa Rica	18	19,081	Hongkong	3,403	2,249,011
Ecuador	6	9,979	Japan	846	856,017
France	29	3,400	Mexico	114	104,529
Hongkong	3,595	3,511,046	Panama	.....	172
Japan	1,362	1,700,332	Peru	431	299,101
Mexico	264	224,247	Straits Settlements	56	44,688
Panama	37	40,614		9,408	6,261,190
Peru	1,827	1,488,516			
Portugal	27	17,760			
Other British East Indies	19	13,071			
Salvador	40	60,042			
Siam	11	8,583			
	11,609	11,413,414			

[a] The ore from France probably originated in Portugal; that from Costa Rica, Panama, Salvador, Bolivia, Chile, Colombia, Ecuador, and most of that from Peru, is probably from Bolivia; that from China, practically all that from Hongkong and half of that from Japan is probably from China.

No record of tungsten ore exported is at hand, although it is known that some has been shipped abroad.

RADIUM, URANIUM, AND VANADIUM.

By Frank L. Hess.

GENERAL CONDITIONS.

The output of uranium and vanadium ores in 1919 amounted to about 14,509 short tons containing 28.96 grams of radium (Ra), 95.7 tons of uranium (112.85 tons of U_3O_8), and 284.2 tons of vanadium. This is an increase over the output in 1918, which amounted to about 18,860 short tons of ore, containing 27.1 grams of radium (Ra), 89.5 tons of uranium (105.5 tons of U_3O_8), and 276 tons of vanadium. As in 1918, the value given to the output must be arbitrary and open to question, for the larger part of the uranium ore was produced by companies which themselves used the ore, and the vanadium ore was largely produced by the Primos Chemical Co., succeeded during the year by the Vanadium Corporation of America, which also reduced the ore, and by the Colorado Vanadium Co., which put up a treatment plant at Sawpit, San Miguel County, Colo., a few miles north of that of the Primos Chemical Co. at Vanadium (formerly Newmire). There is, however, a market for carnotite ore ($K_2O.2UO_3.V_2O_5.8H_2O$), which gives a basis for estimating the value of other similar ores. The approximate value, as ore, of the output in 1919 is estimated at $1,630,900. During the year 28.648 grams of radium in various salts was isolated against 21.7 grams in 1918.

There were several changes of ownership among the companies during the year. The Vanadium Corporation of America bought the American Vanadium Co.'s vanadium deposits at Minaragra, Peru, and its works at Bridgeville, Pa. The corporation later bought the business and properties of the Primos Chemical Co., including the newly rebuilt treatment plant and the vanadium deposits at and near Vanadium, Sawpit, and Placerville, Colo., the tungsten deposits and mill in Boulder County, Colo., the molybdenum deposit and mill at Camp Urad, Clear Creek County, 12 miles west of Empire, Colo., and the treatment plant at Primos, Pa.

The business of the Chemical Products Co. of Denver, with deposits of uvanite (hydrous uranium vanadate, $2UO_3.3V_2O_5.15H_2O$) at Temple Rock, on the San Rafael Swell, 45 miles southwest of Greenriver, Utah, was taken over during a part of 1919 by the Ore Products Corporation.

The price of vanadium in ore was from 50 to 75 cents a pound during the year, and so good was the demand that the vanadium in radium ores was readily purchased. Ferrovanadium sold for about $5 a pound for the contained vanadium, and probably as high as $6 at the end of the year.

The Tungsten Products Co., of Boulder, Colo., began making ferrovanadium and bought a considerable quantity of the tailings of the National Radium Institute at Denver, from which the radium had

been extracted but which at the time they were worked would not pay for the extraction of the vanadium.

The York Metal & Alloys Co. also began the manufacture of ferrovanadium and took over the properties in the La Sal Mountains, Utah, formerly owned by the Consolidated Ores Co. Among radium manufacturers the Standard Chemical Co. made ferrovanadium as a by-product from its radium ores. The other radium companies sold their vanadium in the form of "iron-cake" (hydrous ferric vanadate) to metallurgic works. Besides those already mentioned, the Electro-metallurgical Co., Niagara Falls, N. Y., and the Metal & Thermit Corporation, 120 Broadway, New York City, made ferrovanadium.

The market for uranium salts was poor, for the demand was very light. The Standard Chemical Co. continued to make ferrouranium, which was sold at $7.50 a pound of contained uranium. Several companies made no attempt to save their uranium, owing to the cost of the process and the difficulty of selling the salts.

Nearly 60 per cent of the world's vanadium comes from Peru; most of the other 40 per cent comes from the roscoelite and carnotite fields of southwestern Colorado and southeastern Utah. Small quantities of vanadinite, dechenite, and other oxidized vanadium minerals have also been obtained in New Mexico, Nevada, and Arizona. A little mottramite has been mined in the former German East Africa, now under British control; tyuyamunite, a calcium carnotite, has been mined in Russian Turkestan and treated at Petrograd; and vanadium has from time to time been extracted from the French iron slags and is said to have been thus obtained by the Germans during the great war.

The United States, as the largest steel-making country, is the largest user of vanadium. England, Germany, and France buy ferrovanadium from this country and also buy ores when possible.

The largest producing deposit in the world, that at Minaragra, Peru, is owned by an American company, the Vanadium Corporation of America, but of course the political control is wholly in the hands of Peru.

The exports from Peru and the production in the United States during the last nine years have been as follows:

Approximate world's production of vanadium, 1911–1919.

Year.	Peru (exports of ore).			United States (production of ore and concentrates).
	Quantity (short tons).	Percentage of V_2O_5.	Vanadium contained (short tons).	Vanadium contained (short tons).
1911	2,483	45.00	626	275
1912	3,360	45.00	847	300
1913				432
1914	17	45.00	4	452
1915	3,467	45.58	885	627
1916	3,801	40.00	851	460
1917	4,501	35.78	902	484
1918	2,407	19.10	257	276
1919	3,249	30.41	553	284
	23,285	.....	4,925	3,590

IMPORTS AND EXPORTS.

Value of uranium salts and oxide, including some radium salts, imported for consumption in the United States, 1915–1919.

1915	$17,288
1916	5,065
1917	2,930
1918	[1] 274
1919	[2] 12,960

The imports of "vanadium steel-hardening ores" for consumption in the United States in 1919 amounted to 6,026,005 pounds, valued at $67,846. Vanadium ore imported during the last six months of 1918 amounted to 1,772,215 pounds, valued at $5,333. No separate record was kept prior to July, 1918.

About 3 grams of elemental radium in salts is known to have been exported during 1918. There is no record of any radium exported in 1919.

No separate record is kept of vanadium exports.

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[1] Radium salts only. In addition, 157 pounds of "uranium-radium steel-hardening ores," valued at $4,840, was imported.

[2] Composed of the value of 154 pounds of uranium salts and oxide ($1,309) and of 13 grains of radium salts ($11,651).

GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the gold, silver, copper, lead, and zinc produced in New Mexico from ores and gravels in 1919 showed a decrease of 59 per cent from 1918. There were 92 producing mines, of which 86 were deep and 6 were placer, a decrease of 33 deep mines and of 3 placers.

Mine production of gold, silver, copper, lead, and zinc in New Mexico, 1918–19.

Year.	Ore.	Gold.[a]	Silver.[a]	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	4,749,784	$682,791	782,421	98,264,563	8,398,239	24,050,324	$28,521,413
1919	2,155,998	655,656	837,418	51,150,541	2,886,513	7,594,644	11,814,958
Increase or decrease, 1919	−2,593,786	− 27,135	+ 54,997	−47,114,022	−5,511,726	−16,455,680	−16,706,455

[a] Includes placer production.

During 1919 amalgamating and cyaniding mills in New Mexico treated 74,167 tons of ore, and the bullion saved amounted to $371,888 in gold and 321,303 ounces of silver, the total value in gold and silver being $731,747, an average of $9.86 a ton. The recovery as bullion per ton of ore treated in 1918 was $5.03 in gold and $3.76 in silver, a total of $8.79.

GOLD.

Of the recoverable output of gold from New Mexico ores and gravels in 1919 Colfax and Lincoln counties combined produced 39 per cent, Grant County 37 per cent, and Socorro County (chiefly from the siliceous mines at Mogollon) nearly 23 per cent. Dry and siliceous ores yielded nearly 63 per cent of the total, copper ores nearly 36 per cent, chiefly from the Central and Lordsburg districts, Grant County. Lead ores chiefly from the Victorio district, Luna County, and the Magdalena district, Socorro County, and copper-lead ores furnished a small quantity of gold.

SILVER.

Of the recoverable output of silver from New Mexico ores and gravels in 1919, Socorro County produced 49 per cent, chiefly from siliceous ore from the Mogollon district, the remainder from mixed

ores of the Magdalena district, and Grant County produced 40 per cent, chiefly from the Lordsburg district. Dry and siliceous gold and silver ore, chiefly from Socorro and Grant counties, yielded nearly 65 per cent of the total; copper ores, chiefly from Dona Ana, Grant, and Socorro counties, more than 28 per cent; lead ores, chiefly from the Central district, Grant County, the Victorio district, Luna County, and the Magdalena district, Socorro County, more than 6 per cent; copper-lead ores, chiefly from the Central district, Grant County, and the Magdalena district, Socorro County, a little less than 1 per cent.

COPPER.

Nearly 98 per cent of the copper produced in New Mexico in 1919 came from Grant County, chiefly from the output of the Chino Copper Co. at Santa Rita and from the Lordsburg and Burro Mountain districts. There was a decrease of 37,188,666 pounds in the Central district, a decrease of 10,998,942 pounds in the Burro Mountain district, and an increase of 1,301,461 pounds in the Lordsburg district.

Copper ores, chiefly from Grant, Socorro, and Dona Ana counties, yielded 50,998,068 pounds; dry and siliceous gold and silver ore yielded 45,054 pounds; lead ores, chiefly from Grant County, yielded 68,986 pounds; and copper-lead ores yielded 38,433 pounds.

LEAD.

The principal lead-producing districts in 1919 were the Central district, Grant County; the Magdalena district, Socorro County; and the Victorio district, Luna County. Lead ores produced 2,368,662 pounds, lead-zinc ores, 254,000 pounds, and copper-lead ores 182,485 pounds; the combined content of these classes of ores represented 97 per cent of the total.

ZINC.

Mines producing zinc in New Mexico in 1919 were at Kelly, Socorro County, in the Central and Pinos Altos districts, Grant County, and in Luna County. Zinc ore and concentrates sold in 1919 amounted to 12,365 short tons, carrying an average of 38.35 per cent of zinc, in comparison with 48,935 short tons in 1918, averaging 32.84 per cent.

OUTPUT OF ORE AND METAL CONTENT.

Ore and metals produced in New Mexico in 1919.

Source.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry gold ore	17,741	12,263.89	2,513	283	.....	.....
Dry silver ore	72,455	7,226.26	535,952	33,133	44,413	.....
Dry gold and silver ore	517	231.91	2,269	11,638	20,786	.....
Copper ore	2,027,107	11,295.02	238,271	50,998,068	16,167	.....
Copper-lead ore	320	14.80	6,117	38,433	182,485	.....
Lead ore	6,904	445.59	52,263	68,986	2,368,662	.....
Zinc-lead ore	2,890	.....	.....	.....	254,000	1,253,600
Zinc ore	28,064	.....	.....	.....	.....	6,341,044
	2,155,998	31,477.47	837,385	51,150,541	2,886,513	7,594,644
Placers	.....	239.89	33	.....	.....	.....
	2,155,998	31,717.36	837,418	51,150,541	2,886,513	7,594,644

Placer output in New Mexico in 1919.

County.	Gold.		Silver.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Fine ounces.		*Fine ounces.*		
Colfax and Lincoln	187.94	$3,885	17	$19	$3,904
Grant	51.95	1,074	16	18	1,092
	239.89	4,959	33	37	4,996
Total, 1918	150.83	3,118	21	21	3,139
Increase, 1919	89.06	1,841	12	16	1,857

Content of ores sold or treated in New Mexico in 1919.

Dry and siliceous gold and silver ores.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
GOLD ORES.	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax and Lincoln	17,623	12,084.17	2,409			
Grant	80	70.63	17			
Santa Fe		49.29	10			
Sierra	38	59.80	77	283		
	17,741	12,263.89	2,513	283		
SILVER ORES.						
Grant	12,021	39.62	94,163	30,140	42,558	
Otero	144			79		
Sierra	3,824	26.28	62,435	2,914	1,855	
Socorro	56,466	7,160.36	379,354			
	72,455	7,226.26	535,952	33,133	44,413	
GOLD AND SILVER ORES.						
Grant	517	231.91	2,269	11,638	20,786	

Copper ores.

Dona Ana	1,744		3,415	317,876		
Grant	2,020,689	11,181.72	207,015	49,971,342	4,551	
Otero	61	3.58	25	4,303		
Sandoval	166		1,317	100,000		
Santa Fe	19	3.00	53	3,414		
Sierra	13	101.00	351	2,760		
Socorro	4,340	5.72	26,070	592,905	11,616	
Torrance	75		25	5,468		
	2,027,107	11,295.02	238,271	50,998,068	16,167	

Copper-lead ores.

Grant	203	12.90	2,401	12,729	161,029	
Sierra	117	1.90	3,716	25,704	21,456	
	320	14.80	6,117	38,433	182,485	

Content of ores sold or treated in New Mexico in 1919—Continued.

Lead ores.

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dona Ana	112	.....	1,311	1,447	29,981	.....
Grant	3,334	185.31	30,618	50,062	1,358,492	.....
Luna	1,781	238.30	11,183	1,479	383,248	.....
Santa Fe	106	19.50	579	.....	16,623	.....
Sierra	49	2.00	1,079	.....	26,368	.....
Socorro	1,522	.48	7,493	15,998	553,950	.....
	6,904	445.59	52,263	68,986	2,368,662	.....

Lead-zinc ores.

Socorro	2,890	.....	.....	.....	254,000	1,253,600

Zinc ores.

Grant	22,744	.....	.....	.....	.....	4,567,329
Luna	69	.....	.....	.....	.....	31,575
Socorro	5,251	.....	.....	.....	.....	1,742,140
	28,064	.....	.....	.....	.....	6,341,044

SMELTERS.

The only smelter in operation in New Mexico in 1919 was the zinc oxide plant at Waldo, near Cerrillos, Santa Fe County, built in 1917. The bulk of the copper ore and concentrates continued to be shipped to the copper smelter at El Paso. Lead ores and siliceous ores were shipped to the lead plant at El Paso. Copper ores, siliceous ores, and iron ores were shipped to the Copper Queen and the Calumet smelters, at Douglas, Ariz. Zinc ore and concentrates were shipped to smelters and zinc oxide plants in Kansas, Oklahoma, and the Eastern States.

MINING INDUSTRY.

The outstanding features of mining in New Mexico in 1919 were the decrease in number of producing mines; the increased production of gold and silver in the Mogollon district, notwithstanding the closing of the Fanney mill, and the decreased output of gold from the Aztec mine; the increased output of silver in Sierra County and the large amount of development work done in that county; the operation of the Chino Copper Co.'s plant at only 50 per cent of capacity; the closing of the Burro Mountain mill in June; the decreased output of gold and silver bearing siliceous copper ores of Lordsburg; the cessation of shipments of copper ores from Otero County; the idleness of the lead and zinc mines at Cooks Peak; the moderate production of lead-silver ores from Gage; the idleness of the Graphic flotation mill in the lead-zinc district at Magdalena; and the curtailed operations at the zinc mines at Hanover.

Mine production of gold, silver, copper, lead, and zinc in New Mexico in 1919.

County.	Number of mines producing.	Ore.	Gold.[a]		Silver.[a]	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Colfax and Lincoln[b]	7	17,623	12,272.11	$253,687	2,426	$2,717
Dona Ana	3	1,856	.....	.....	4,726	5,293
Grant	46	2,059,588	11,774.04	243,391	336,499	376,879
Luna	8	1,850	238.30	4,926	11,183	12,525
Otero	2	205	3.58	74	25	28
Sandoval	1	166	.....	.....	1,317	1,475
Santa Fe	4	125	71.79	1,484	642	719
Sierra	9	4,041	190.98	3,948	67,658	75,777
Socorro	10	70,469	7,166.56	148,146	412,917	462,467
Torrance	2	75	.....	.....	25	28
Total, 1918	92	2,155,998	31,717.36	655,656	837,418	937,908
	128	4,749,784	33,030.02	682,791	782,421	782,421
Increase or decrease, 1919	−36	−2,593,786	−1,312.66	−27,135	+54,997	+155,487

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Colfax and Lincoln[b]	.....	.....	.....	.....	.....	.....	$256,404
Dona Ana	319,323	$59,394	29,981	$1,589	.....	.....	66,276
Grant	50,075,911	9,314,119	1,587,416	84,133	4,567,329	$333,415	10,351,937
Luna	1,479	275	333,248	20,312	31,575	2,305	40,343
Otero	4,382	815	.....	.....	.....	.....	917
Sandoval	100,000	18,600	.....	.....	.....	.....	20,075
Santa Fe	3,414	635	16,623	881	.....	.....	3,719
Sierra	31,661	5,889	49,679	2,633	.....	.....	88,247
Socorro	608,903	113,256	819,566	43,437	2,995,740	218,689	985,995
Torrance	5,468	1,017	.....	.....	.....	.....	1,045
Total, 1918	51,150,541	9,514,000	2,886,513	152,985	7,594,644	554,409	11,814,958
	98,264,563	24,271,347	8,398,239	596,275	24,050,324	2,188,579	28,521,413
Increase or decreae, 1919	−47,114,022	−14,757,347	−5,511,726	−443,290	−16,455,680	−1,634,170	−16,706,455

[a] Includes placer production.
[b] In order to avoid disclosing individual figures, the production of Colfax and Lincoln counties is combined.

Gold and silver produced at mills in New Mexico, 1918–19.

Year.	Ore to gold and silver mills.	Gold in bullion.	Silver in bullion.	Ore to concentrating mills.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
1918	70,179	17,081.09	264,070	4,551,983
1919	74,167	17,990.07	321,303	1,987,943
Increase or decrease, 1919	+3,988	+908.98	+57,233	−2,564,040

Mine production of metals from New Mexico concentrates, 1918–19.

Year.	Quantity of concentrates.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1918	353,761	11,910.21	210,026	92,609,319	52,374	12,480,507
1919	155,136	4,655.34	179,760	46,240,975	9,534	3,228,834
Decrease, 1919	198,625	7,254.87	30,266	46,368,344	42,840	9,251,673

Mine production of metals from New Mexico crude ore shipped to smelters, 1918–19.

By years.

Year.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1918	127,622	3,887.89	308,304	5,635,244	8,345,965	11,569,817
1919	93,888	8,832.06	336,322	4,909,566	2,876,979	4,365,810
Increase or decrease, 1919	−33,734	+4,944.17	+28,018	−745,678	−5,468,886	−7,204,007

By kinds of ore (1919).

Dry gold ore	40	70.40	83	283	.....	.....
Dry silver ore	4,989	65.88	80,446	23,766	34,879	.....
Dry gold and silver ore	517	231.91	2,269	11,638	20,786	.....
Copper ore	72,889	8,003.48	195,144	4,766,460	16,167	.....
Copper-lead ore	320	14.80	6,117	38,453	182,485	.....
Lead ore	6,904	445.59	52,263	68,986	2,368,662	.....
Zinc-lead ore	2,890	.....	.....	.....	254,000	1,253,600
Zinc ore	5,339	.....	.....	.....	.....	3,112,210
	93,888	8,832.06	336,322	4,909,566	2,876,979	4,365,810

Mine production of metals from New Mexico crude ore and concentrates combined shipped to smelter, 1918–19.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
1918	481,383	15,798.10	518,330	98,264,663	8,398,239	24,050,324
1919	249,024	13,487.40	516,082	51,150,541	2,886,513	7,594,644
Decrease, 1919	232,359	2,310.70	2,248	47,114,022	5,511,726	16,455,680

Mine production of metals from New Mexico crude ore shipped to smelters, 1919.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Colfax	2	10.60	6	.....	.....	.....
Dona Ana	1,856	.....	4,726	319,323	29,981	.....
Grant	74,415	8,359.92	217,187	3,834,936	1,577,882	1,885,695
Luna	1,859	238.30	11,183	1,479	383,248	31,575
Otero	205	3.38	25	4,382	.....	.....
Sandoval	166	.....	1,317	100,000	.....	.....
Santa Fe	125	22.50	632	3,414	16,623	.....
Sierra	4,041	190.98	67,658	31,661	49,679	.....
Socorro	11,133	6.18	33,563	608,903	819,566	2,448,540
Torrance	75	.....	25	5,468	.....	.....
	93,888	8,832.06	336,322	4,909,566	2,876,979	4,365,810

Gold and silver contained in bullion produced at mills in New Mexico, 1919.

Process.	Ore.	Gold in bullion.	Silver in bullion.	Quicksilver used.	Sodium cyanide used.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Amalgamation	17,701	11,681.39	2,452	300	.....
Cyanidation	56,466	6,308.68	318,851	.....	108,805
	74,167	17,990.07	321,303	300	108,805

REVIEW BY COUNTIES.

BERNALILLO COUNTY.

Assessment and development work only was done in the Coyote, Hell Canyon, and Soda Springs districts.

COLFAX COUNTY.

Elizabethtown district (including Baldy).—The 10-stamp amalgamation-concentration mill of the Aztec mine, at Baldy, was operated the entire year, with regular monthly shipments of gold bullion and occasional shipments of concentrates carrying a high content of gold. Much development work was done at the Ajax mine, on Willow Creek. The Lowry placer, at Elizabethtown, was operated from April through October, with two to four men, and yielded an appreciable quantity of gold bullion, averaging 0.901 in fineness of gold and 0.096 in fineness of silver.

DONA ANA COUNTY.

Organ Mountain district.—Lessees shipped a considerable quantity of copper oxidized ore and some lead oxidized ore from the Torpedo and Memphis mines. Two cars of lead-silver ore were shipped from the Bennett-Stephenson mine.

GRANT COUNTY.

Mine production in Grant County, N. Mex., 1918–19.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Zinc.	Total value.
		Placer.	Deep.					
	Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	4,602,458	$672	$269,380	[a]338,833	96,939,381	3,158,493	11,876,428	$25,857,920
1919	2,059,588	1,074	242,317	[b]336,499	50,075,911	1,587,416	4,567,329	10,351,937
Increase or decrease, 1919..	−2,542,870	+402	−27,063	−2,334	−46,863,470	−1,571,077	−7,309,099	−15,505,983

[a] Includes 9 ounces of placer silver.
[b] Includes 16 ounces of placer silver.

Apache No. 2 (Anderson) district.—During the operation of the Apache mine from June through December several hundred tons of silver-copper oxidized ore was shipped, part of which contained also bismuth, for which payment was received.

Black Hawk district.—A car of silver ore was shipped from the Fleming mine.

Burro Mountain district.—The 1,500-ton gravity and flotation-concentration mill of the Burro Mountain Branch of the Phelps Dodge Corporation was operated from January to June. From July through December extensive development work was done at the mines, and many changes and additions were made at the mill. Various lessees on the property throughout the year shipped several thousand tons of oxidized copper ore.

Central district.—The output of the Central district, embracing the towns of Bayard, Fierro, Georgetown, Hanover, and Santa Rita, was

1,789,083 tons of ore, yielding $57,280 in gold, 34,508 ounces of silver, 40,358,634 pounds of copper, 1,283,642 pounds of lead, and 4,299,658 pounds of zinc, with a total value of $7,984,543, as compared with $20,400,099 in 1918. Despite this decrease this district remained the most productive district in New Mexico. Besides the Chino Copper Co.'s mines, at Santa Rita, and the Empire Zinc Co.'s mines, at Hanover, there were 10 other producing mines in the district.

Copper ore was shipped from the Hanover-Modoc group and from the Dewey and Schley mines. A large quantity of lead sulphide and oxidized ore was shipped from the Lucky Bill, and several hundred tons of lead oxidized ore was shipped from the Groundhog mine. Zinc carbonate ore was shipped from the Hanover mines of the Empire Zinc Co. and from the Hanover Copper Co.'s group. The Empire Zinc Co. also operated its 150-ton magnetic separating plant, but not at full capacity, on zinc sulphide ores from its mines. A large quantity of zinc sulphide smelting ore was shipped from the Welch mine. The Grant County Copper Co. built a 50-ton concentration mill in 1919.

The Chino Copper Co. has been mining since 1910 a low-grade copper deposit at Santa Rita by steam shovels. The ore is concentrated at Hurley, where the company's 7-section wet concentration and flotation mill is located. Concentrates are shipped to the El Paso Smelting Works. During 1919 the plant was operated at 50 per cent of capacity.

The tenth annual report of the Chino Copper Co. for the year ending December 31, 1919 (dated Apr. 9, 1920), says:

The total net income for the year 1919 amounted to $1,301,797, or at the rate of $1.50 per share, as compared with $3,908,222, or $4.49 per share, for the year 1918. This marked decrease in earnings is accounted for by the smaller production and the lower price of copper for 1919, as compared with those of the year 1918. As noted in the quarterly reports issued during 1919, production was cut to about 50 per cent of capacity, beginning January 1, 1919, and has since continued at that rate.

The average price received for copper delivered during the year was 18.784 cents per pound.

The net operating income was $1,038,909; miscellaneous income $69,589; adjustment of treatment charges, etc., $193,299; or a balance to surplus account of $1,301,797.

Gross copper production for the year in concentrates and precipitates was 42,325,449 pounds. After smelter deductions, the net production was 40,488,706 pounds. In addition there were also produced gold and silver valued at $17,928.

The net cost of producing copper for the year was 15.53 cents per pound, as compared with 14.13 cents per pound for the year 1918.

During the year 1919 there were no changes in the area of mining property. The company owns and controls 206 mining claims having an area of 3,493 acres, of which all but 438 acres are patented. In addition to these areas the company owns 120 acres of agricultural land adjacent to its group of mining claims, which make a total of 3,613 acres owned and controlled by the company in the Central mining district.

At the close of the fiscal year the total area owned and controlled by the company in connection with its mill location at Hurley and its various water rights and tailings disposal system was 18,531 acres, final title having been confirmed as to all but 800 acres.

Only two development drill holes were completed during the year, adding 924 feet to development drilling for 1919, making the total drilled since the beginning of operations 265,672 feet.

No recalculation of ore reserves has been made since December 31, 1918, when a total of 114,528,175 tons, having an average grade of 1.66 per cent copper, was reported as being fully developed by churn drilling. Since the beginning of operations there has been milled or shipped direct to the smelter a total of 19,746,650 tons of ore averaging 1.86 per cent copper, leaving a total of ore unmined together with that mined but untreated and stored in stock piles as of December 31, 1919, of 94,781,525 tons, averaging 1.62 per cent copper. In addition to ore reserves stated above there

are considerable tonnages of partially developed ore based on scout drill holes that are over 200 feet apart.

The total ore and waste removed by steam shovels during the year was 4,279,831 cubic yards. Of this amount 3,161,381 cubic yards were stripping, the remainder being equivalent to 2,243,346 tons of ore. Of the ore that was removed 1,770,479 tons were sent to the mill and 472,867 tons were sent to the stock piles. At the end of the year there was a total of 1,355,691 tons of ore, averaging 1.56 per cent copper, in the ore stock piles.

From the beginning of steam-shovel operations of September 23, 1910, when the first shovel was erected, there has been removed a total of 37,867,939 cubic yards of material, of which 27,025,136 cubic yards were stripping, the remainder being equivalent to 21,187,101 tons of ore. Of this latter, 1,355,691 tons remained stored in the ore stock piles, 88,465 tons are being experimentally treated in the heap-leach pile at the mine, while 19,719,157 tons have been shipped to the mill and 23,788 tons were shipped direct from the steam shovels to the smelter.

Of the ore shipped to the mill during the year, 27.6 per cent came from the Northwest ore body, 31.2 per cent came from the North ore body, 32 per cent came from the South ore body, 8 per cent came from the Southwest ore body, and 1.2 per cent came from the stock piles.

The average cost of steam-shovel operations for the removal of both ore and stripping for the year was 64.91 cents per yard compared with 69.55 cents for the year 1918 and 33.97 cents for 1915. The ratio of the cost of labor for the removal of ore and stripping in 1919, compared with 1915, is as 1.75 is to 1; while the cost of supplies is as 2.16 is to 1; and the ratio of all costs including general administration, taxes, and depreciation is 1.91 to 1.

During the year a part of the new section 7 was operated as a regular concentrating unit. The equipment for the leaching portion of this section was finally received in the early part of this year, but this part of it has not yet been put in commission, partly because it was not necessary to use it under curtailed production and partly for the reason that certain steps of the metallurgy to be employed here have not been fully worked out in detail.

In August, 1919, a tailings air-lift installation was put in operation. This raises the tailings approximately 40 feet, giving the necessary elevation to carry them to the new lower tailings storage by gravity. Although this installation is a departure from the ordinary methods of elevating tailings, the plant has demonstrated its operating economy and has effected a substantial decrease in the cost of tailings disposal.

During the year 1919 there was treated in the mill at Hurley a total of 1,765,200 dry tons of ore, compared with 3,836,400 dry tons of ore treated during the year 1918. This tonnage is equivalent to an average of 4,836 tons per day, compared with an average of 10,510 tons per day for the year 1918, a decrease of 5,674 tons per day, corresponding to 54 per cent. The average content of the ore treated during the year was 1.82 per cent copper, or approximately 0.2 per cent higher than that treated during the year 1918. The total production of concentrates amounted to 128,154 dry tons, which averaged 16.5 per cent copper. The total copper content of the concentrates was 42,302,728 pounds, which is 52.5 per cent of the average production for the previous two years. This corresponds to a recovery of 23.97 pounds per ton of ore, equivalent to an extraction of 65.67 per cent, which extraction was 2.4 per cent higher than for the year 1918. This improved result was due to the fact that an ore of a better concentrating character was milled during the year 1919 than during the previous year, although considerable tonnages of low-grade oxidized material coming from the upper benches of the Southwest ore body were still included unavoidably as ore, thus making high recoveries impossible.

The average cost of milling was $1.56 per ton, being an increase of 19 cents per ton, or approximately 13.5 per cent over that for the year 1918. This increase is mainly due to the smaller tonnage treated during 1919 as compared with 1918. The ratio of increased cost of labor per ton of ore milled in 1919 compared with 1915 is as 1.98 is to 1; of supplies is as 2.77 is to 1; and the ratio of all costs calculated on the same basis, including labor, supplies, administration, depreciation, and taxes, except Federal taxes, for the same years is as 2.31 is to 1.

During the year there was shipped from the mine direct to the smelter a total of 34 tons of copper precipitate, containing 22,721 gross pounds of copper.

The production of copper contained in the concentrates and other shipping products for the year was 42,325,449 pounds, as compared with 79,340,372 pounds for 1918 and an average for the years 1917 and 1918 of 81,340,075 pounds. After allowing for smelter deductions, the net output for the year was 40,488,706 pounds, as against a total of 75,655,641 pounds produced in 1918.

The average operating cost per pound of copper produced for the year, excluding charge for Federal income and profits taxes and without credit for precious-metals val-

ues and regular miscellaneous income, was 15.53 cents as compared with 14.13 cents per pound calculated in the same way for the year 1918. The credit for precious metals amounted to 0.044 cent per pound of copper, and that for miscellaneous income amounted to 0.172 cent per pound, making a total of 0.216 cent for 1919, as against 0.109 cent for 1918.

The per pound cost, 15.53 cents, as stated for the year 1919, includes depreciation and charges for accrual of all taxes except Federal income and profits taxes, for which no reserves were set up in 1919. From the cost for the year 1918 as shown above for purposes of comparison a charge of 3.16 cents per pound is deducted for such Federal tax reserves as were established in that year. Applying the usual credits for gold and silver values and for the regular miscellaneous income for both years as above stated and excluding Federal taxes for both years, the net cost for 1919 is 15.31 cents per pound, as compared with 14.02 cents for the previous year.

Chloride Flat district.—In the mining during 1918–19 of a large quantity of iron-manganese ores near Silver City (shipped to steel and chemical works only) a small car of silver-manganese ore was extracted and shipped to the lead smelter at El Paso in 1919.

Eureka district (including Sylvanite).—Lessees operating the American mine from June through December shipped 200 tons of lead-silver ore, and lessees operating the Tom Wright group from January through June shipped several cars of copper-silver ore. Continuous operations on the King 400 mine resulted in the shipment of a considerable quantity of silver-sulphide ores carrying also lead and copper.

Fremont district.—No shipments were made from the Fremont district in 1919.

Gold Hill district.—The Standard (or Cline) mine, opened by a short adit, was operated for three months by the labor of the owner alone. The ore, siliceous oxidized, yielded very good returns in the 2-stamp amalgamation mill on the property. The Cooperative Mining Co. began the construction of a water concentration and flotation mill.

Lordsburg district (including Pyramid and Virginia or Shakespeare districts).—The production from the Lordsburg district in 1919 from eight mines was 77,002 tons, carrying $175,008 in gold, 242,733 ounces of silver, 3,516,457 pounds of copper, and 53,264 pounds of lead, and having a gross value of $1,103,753, as compared with $832,464 in 1918. All five metals showed increases. The principal producing property was the group operated by the Eighty-Five Mining Co. The ore from this mine, a siliceous ore carrying gold and silver bearing copper sulphides, was shipped in large quantities direct to El Paso, Tex., and Douglas, Ariz. During the first three months of the year this company also operated its 200-ton water concentration and oil flotation mill. A large quantity of siliceous oxidized silver ore from the Last Chance mine was treated in the water concentration and oil flotation mill on the property, with a highly concentrated product of high-grade silver concentrates. Other producing mines were the Atwood, Bonney, Miser's Chest, and Ruth.

Pinos Altos district.—Deep mines in the Pinos Altos district in 1919 produced only 2,912 tons of ore, carrying $5,044 in gold, 2,508 ounces of silver, 14,452 pounds of copper, 20,906 pounds of lead, and 267,671 pounds of zinc, with a total value of $31,189. Placer mines in this district produced 51.95 fine ounces of gold and 16 ounces of silver, with a total value of $1,092. The Cleveland zinc mine and its magnetic separating mill were operated for a short period only before being permanently closed. The Mexarko Co. shipped from the Langston mine several hundred tons of gold and silver ore, car-

rying some lead and copper. Several small shipments of silver-copper ore were made from other properties.

Steins district.—A car of silver ore was shipped from the Pach-la-ki mine and several cars of silver ore that had been mined from the surface from the Volcano mine.

Steeplerock district.—Operations at the Carlisle mine were confined to development, to repairs and changes of mine and mill machinery, and to keeping the Carlisle shaft unwatered. From this mine several tons of silver-bearing lead-copper ore and several hundred tons of concentrates of similar character were shipped. A small lot of silver-copper ore and a car of silver siliceous ore were shipped from the New Years Gift group. The Duncan Mining & Milling Co. completed an 80-ton cyanidation mill in the district in 1919.

Thompson Canyon district.—A small lot of silver-lead ore was shipped from the Brock mine.

White Signal district.—Several cars of copper ore were shipped from the Paymaster mine.

LINCOLN COUNTY.

No mining was done in 1919 in the Estey district (Oscuro Mountains) or the Jicarilla district.

Nogal (Bonito Parsons) district.—The Vera Cruz Leasing Co., which had reopened a property in the Nogal district in 1918 with reconstruction of a 50-ton amalgamation ball mill, carried on development work of the mine and operation of the mill from April through September. A new 50-ton mill was also installed.

Whiteoaks district.—During part of the year the Homestake 20-stamp amalgamation mill was operated on ore from the North Homestake and South Homestake mines.

Red Cloud (Gallinas Mountains) district.—The Red Cloud mine was reopened in 1919, a new shaft was sunk 100 feet, and 45 feet of drifts were run.

LUNA COUNTY.

Luna County in 1919 produced 1,850 tons of ore, carrying $4,926 in gold, 11,183 ounces of silver, 1,479 pounds of copper, 383,248 pounds of lead, and 31,575 pounds of zinc, and having a total value of $40,343, as compared with $102,432 in 1918.

Cooks Peak district.—Very little mining was done in the Cooks Peak district in 1919. The total quantity of both lead and zinc ores shipped was only 122 tons.

Victorio (Gage) district.—Lessees on the Helen and Jessie mine had a considerable force of miners at work nearly all the year and shipped an appreciable quantity of lead-silver ore. Several hundred tons of lead-silver ore was shipped from the Chance mine, also in operation nearly all the year.

OTERO COUNTY.

No work was done in the Highrolls (Sacramento) and Tularosa districts in 1919.

Jarilla (Orogrande, Silver Hill) district.—The Jarilla district shipped much iron ore to the steel plant at Pueblo, Colo., up to November 1, when the labor strike at Pueblo stopped all shipments. Ordinarily this district also sends considerable quantities of gold and silver bearing iron and copper ores to the smelter at El Paso, but in 1919 it shipped only 205 tons of these ores, carrying $74 in gold, 25 ounces

of silver, and 4,382 pounds of copper, with a total value of $917, as compared with $69,735 in 1918.

RIO ARRIBA COUNTY.

No production was made from the copper prospects in Rio Arriba County.

SANDOVAL COUNTY.

Cochita (Bland) district.—Some development work was done at the Crown Point mine.

Nacimiento Mountains district.—Several cars of silver-copper oxidized ore were shipped by the San Miguel Mining Co., at Senorito.

SAN MIGUEL COUNTY.

Development work, begun in 1918, was continued by the Pecos Mines Co. at its property at the junction of Willow Creek and Pecos River.

SANTA FE COUNTY.

Deep mines in Santa Fe County (there were no producing placers in 1919) produced 125 tons of ore, carrying $1,484 in gold, 642 ounces of silver, 3,414 pounds of copper, and 16,623 pounds of lead, having a total value of $3,719, as compared with $74,715 in 1918.

Cerrillos district.—The Grubnau, Bryant & Grubnau zinc oxide plant at Waldo, built and placed in operation in 1917, continued operations in 1919 on New Mexican and Mexican zinc carbonate ores. None of the mines in this district were operated in 1919.

New placers (Golden) district.—Considerable development work was done at the Amazon-Anaconda Lincoln group by the Collier Mines Co., and several cars of lead-silver ore were shipped. Small lots of ore were shipped from the Copper Basin No. 1, and from the Gold King mine. During 1918 and 1919, the Argo Mining Co. has been developing the Las Vegas property. In 1919 this company extracted a considerable pocket of gold, which was sold as specimens.

SIERRA COUNTY.

Mine production in Sierra County, N. Mex., 1918–19.

Year.	Ore.	Gold.		Silver.	Copper.	Lead.	Total value.
		Placer.	Deep.				
	Short tons.			*Fine ozs.*	*Pounds.*	*Pounds.*	
1918	801	.....	$568	18,536	42,053	25,915	$31,331
1919	4,041	.....	3,948	67,658	31,661	49,679	88,247
Increase or decrease, 1919	+3,240	.....	+3,380	+49,122	−10,392	+23,764	+56,916

No shipments were made from the Caballos Mountains district in 1919, and no work was done in the Hermosa district.

Chloride (Apache, Cuchillo Negro) district.—Much development work was done at the Silver Monument mine, and the 25-ton concentration mill was repaired and made ready for operation.

Hillsboro (Las Animas) district.—From September through December much development work was done by the Hillsboro Development Co. on the Bonanza mine, and a small lot of gold and silver-bearing

copper ore was shipped to El Paso. The Snake & Opportunity Mines Co., throughout the year, employed a large force of men on development work on a large area of mineral land known as the Snake group, and shipped one car of gold ore.

Kingston district.—The Percha Mining Co. employed a small force of men throughout the year at the Percha group. Much development work was done, and several cars of lead-copper-silver ore were shipped. Development operations with a considerable force of men were continuous at the Lady Franklin group, and several hundred tons of good-grade silver ore were shipped. A small force of men was employed steadily at the Virginian mine on development work, during the course of which a car of silver ore was mined and shipped.

Lake Valley district.—Beginning in June and continuing throughout the year lessees on the Lake Valley mine opened up this old property and shipped a large quantity of siliceous oxidized silver ore. Throughout the year the Roper group (formerly the Good Luck property) was operated by a considerable force of men on extensive development work, and two cars of lead-sulphide ore were shipped to El Paso.

SOCORRO COUNTY.

Mine production in Socorro County, N. Mex., 1918–19.

Year.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
	Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	112,947	$120,140	352,878	585,717	3,078,380	11,501,879	$1,882,926
1919	70,469	148,146	412,917	608,903	819,566	2,995,740	985,995
Increase or decrease, 1919	−42,478	+28,006	+60,039	+23,186	−2,258,814	−8,506,139	−896,931

Magdalena (Kelly) district.—The production in the Magdalena district for 1919 amounted to 13,938 tons of ore, yielding $10 in gold, 30,117 ounces of silver, 599,382 pounds of copper, 819,566 pounds of lead, and 2,995,740 pounds of zinc, and having a total value of $407,352, as compared with 56,295 tons of ore, having a total value of $1,456,931, in 1918.

Both lead and zinc carbonate ores in considerable quantities were shipped from the Kelly mine. The Graphic mine was operated the entire year, with shipments of copper sulphide, lead oxidized, zinc-lead sulphide, zinc-lead oxidized, and zinc oxidized ores. The Graphic 150-ton oil flotation mill was operated only for testing purposes for short periods. Copper sulphide and zinc oxidized ores were shipped from the Hardscrabble mine, lead and zinc oxidized ores from the Juanita mine, and zinc oxidized ore from the South Juanita mine.

Mogollon (Cooney) district.—The Mogollon district in 1919 produced 56,531 tons of ore, yielding $148,136 in gold, 382,800 ounces of silver, and 9,521 pounds of copper, and having a total value of $578,643, as compared with 56,452 tons of ore, having a total value of $422,690, in 1918. The district remained the principal silver-producing district in New Mexico, with a silver output representing 46 per cent of the State yield. The output of gold from this district represented only 23 per cent of the total output of gold in the State.

The Fanney mine and 250-ton cyanidation mill were operated only o April 1, 1919. The Mogollon Mines Co.'s concentration and cyanidation mill was operated steadily on ores from the Last Chance, Top, Confidence, Deadwood, and other mining claims in the district.

TAOS COUNTY.

Only development work was done in the Copper Mountain (Picuris) and Red River districts, and no work was done in the Rio Hondo district.

TORRANCE COUNTY.

Several cars of copper ore were shipped from the Carocito district.

GOLD, SILVER, COPPER, AND LEAD IN TEXAS.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

The total value of the gold, silver, copper, and lead produced in Texas in 1919 was the largest gross value reported since the beginning of the mining industry of the State, in 1884. The yield of silver, the principal metal produced, showed a small decrease in quantity, but the total value for silver at the increased average price was greater than in 1918. The Presidio silver mine, at Shafter, equipped with a large cyanidation mill, produced a little less than for several years, but its output continued to represent the greater part of the State total. From the Copper Queen mine, at Van Horn, a car of copper-silver ore was shipped.

Mine production of gold, silver, copper, and lead in Texas, 1918–19.

Year.	Gold.	Silver.		Copper.		Lead.		Total value.
		Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
		Fine ozs.		*Pounds.*		*Pounds.*		
1918	$25	576,565	$576,565	9,308	$2,299	26,944	$1,913	$580,802
1919	25	538,642	603,279	979	182	13,131	696	604,182
Increase or decrease, 1919	.....	−37,923	+26,714	−8,329	−2,117	−13,813	−1,217	+23,380

REVIEW BY COUNTIES.

Brewster County.—The Metals Products Association continued the construction, at Alpine, of a 50-ton smelter for the treatment of lead-silver ores.

Burnet County.—Some development work was done at copper prospects near Burnet.

Culberson County.—A car of copper ore was shipped from the Copper Queen mine, at Van Horn.

Hudspeth County.—All the prospects at Allamoore and Sierra Blanca were idle.

Presidio County.—Operations were continuous at the Presidio mine, in the Shafter district, from which the greater part of the silver output of the State has come since 1884. The ore, chiefly silver chloride (horn silver), is treated in a 125-ton cyanidation mill.

TIN.

By Adolph Knopf and Bertrand L. Johnson.

PRODUCTION AND DEVELOPMENT.

So far as known all the concentrates produced in tin-mining operations in the United States in 1919 were won from gravels mined in Alaska.

Tin mined in the United States (including Alaska), 1907–1919, in short tons.

[Metallic tin estimated as obtainable from concentrates produced in tin-mining operations in the United States (including Alaska).]

1907	60	1914	104
1908	30	1915	102
1909	20	1916	140
1910	40	1917	110
1911	70	1918	69
1912	130	1919	56
1913	55		

Alaska.—Alaska produced 86 short tons of tin concentrate in 1919, 18 less than in 1918. The recoverable content of metallic tin of this concentrate is estimated to be 56 short tons.

The York district, on Seward Peninsula 100 miles northwest of Nome, continues to be the center of the tin-mining industry of Alaska. The dredges of the American Tin Mining Co., on Buck Creek, and the York Tin Dredging Co., on Grouse Creek, were both in operation. Three men were also engaged in shoveling into sluice boxes on Buck Creek above the dredge. Development was continued at the Lost River tin-lode mine, about 15 miles east of the York placer-tin district. The winter work consisted mainly of retimbering, enlargement of drifts and shafts, and deepening of shafts. A number of buildings were erected, and a compressor plant was installed to furnish air for drills and for ventilation. A large warehouse was also built on the beach at the mouth of the river. A considerable shipment of mining machinery and supplies for this property was landed at the mouth of Lost River in October, 1919.

A few hundred pounds of tin concentrates were saved in gold mining on Humboldt Creek, a tributary of Goodhope River.

In the Hot Springs district about 30 tons of tin concentrates containing about 18 short tons of metallic tin was produced from the gold placers.

South Dakota.—Only development work was done on the Cowboy, Mohawk, and Tin Boom claims of the National Tin Corporation near Hill City, S. Dak. Six hundred feet of lateral work was done on

the Cowboy property, and a third compartment was sunk 300 feet. A 100-foot shaft was sunk on the Mohawk, and 600 feet of drift run. Fifty men were employed by the company.

The Rare Minerals Co. employed about 10 men during the year in the further development of its mining properties at Oreville, Pennington County. The development work, mainly open cut, was confined to the Louise group of claims and to the Tin King.

More or less open-cut work and shaft sinking for prospecting is reported to have been done on the Frederic tin mine.

New Mexico.—Prospecting continued during the year to determine the extent of the newly discovered tin-bearing area on the headwaters of the East Fork of Gila River. Tin occurs here in the peculiar variety of tin oxide known as wood tin and was first discovered in place in 1919.[1] It is found in stream gravels and has been derived from small veinlets inclosed in rhyolite. The prospecting done so far shows that it occurs in Kennedy, Corduroy, and Whitewater (locally known as Taylor) canyons, in an area 10 miles long from north to south. The topography of this area is shown on the map of the Alum Mountain quadrangle of the United States Geological Survey.

Virginia.—Work at the Martha Cash tin mine, in Rockbridge County, Va., which had been commandeered by the Government during the war and leased to private persons, was discontinued early in 1919.

SMELTING.

Six tin-smelting plants in operation in the United States in 1919 produced 12,236 short tons of metallic tin. Practically the whole of the output was smelted from Bolivian concentrate. The largest output was made by the American Smelting & Refining Co. at its plant at Perth Amboy, N. J. Other producing concerns were the Williams Harvey Corporation, Jamaica Bay, Brooklyn, N. Y.; the Andes Electin Co., New York City; the Eastern Metal & Refining Co. (Inc.), Boston, Mass.; the Norton Laboratories (Inc.), Lockport, N. Y.; and the Seaboard Metal Corporation, Arlington, N. J. The smelting of imported tin-bearing concentrate in this country was begun in 1916.

Smelter output of metallic tin in the United States, 1916–1919, in short tons.

1916	2,261	1918	10,284
1917	6,065	1919	12,236

IMPORTS AND EXPORTS.[2]

Tin ore imported into the United States, 1916–1919.

[General imports.]

Year.	Quantity (short tons).	Value.
1916	8,040	$4,032,460
1917	9,054	4,743,099
1918	18,394	11,444,401
1919	19,196	11,871,948

[1] Knopf, Adolph, U. S. Geol. Survey Mineral Resources, 1918, pt. 1, p. 26, 1919.

[2] Statistics of imports and exports compiled from the records of the Bureau of Foreign and Domestic Commerce.

Tin imported as metal and entered for consumption in the United States, 1906–1919.

Year.	Quantity (short tons).	Value.	Year.	Quantity (short tons).	Value.
1906	50,476	$37,447,315	1913	52,329	$46,927,213
1907	41,257	32,074,263	1914	47,530	32,881,619
1908	41,267	23,923,560	1915	57,792	38,736,909
1909	47,662	27,558,546	1916	69,035	51,802,232
1910	52,528	33,913,255	1917	72,166	63,860,340
1911	53,527	43,346,394	1918	71,254	93,144,218
1912	58,016	50,372,478	1919	44,849	50,890,019

Of the tin imported in 1919—44,849 short tons was tin imported "in bars, blocks, pigs, or grain or granulated," and 12,200 short tons is estimated as obtainable from the 19,196 short tons of concentrate (mainly Bolivian), containing 63 ± per cent of recoverable tin, which was imported during the year. The imports came from the following countries, but the real origin of the tin is not wholly disclosed by this table:

Tin imported into the United States in 1919, in short tons.

[General imports.]

Straits Settlements	28,790	Canada	824
Bolivia (recoverable tin content of ore)	12,200	Chile	221
England	10,622	Hongkong	103
Dutch East Indies	2,525	Other countries	116
Australia	1,648		57,049

Exports of tin ore are insignificant and are not recorded. Exports of metallic tin in pigs, bars, etc., amounted to 20 short tons in 1918 and 306 short tons in 1919.

CONSUMPTION.

The new or primary tin available for consumption is the sum of the metallic tin imported and the tin produced by the domestic smelters operating largely on imported concentrate, mainly from Bolivia, minus the exports of metallic tin. The metal imported and entered for consumption in 1919 was 44,849 short tons, the tin produced by the domestic smelters was 12,236 short tons, and the exports were 306 short tons. The total supply of new or primary tin available for consumption was therefore 56,779 short tons.

New tin available for consumption, 1913–1919, in short tons.

1913	52,329	1917	78,231
1914	47,530	1918	81,538
1915	57,792	1919	56,779
1916	71,296		

PRICES.

The average price of spot Straits tin in New York in 1919 was 65.54 cents a pound, as compared with 86.80 cents in 1918.[3] The course of the market during the year is shown in the following table:

[3] Metal Statistics, 1921, p. 355. Approximate averages based on sales of Straits and other grades of pure tin for prompt delivery, for the most part in small lots.

Average monthly prices, in cents per pound, of Straits tin in New York in 1919.[3a]

January	72.50	May	71.94	September	55.81
February	72.00	June	71.20	October	55.62
March	71.75	July	70.39	November	54.17
April	72.26	August	63.78	December	55.06

The average price for the year in London was £257 9s. 8d per ton of 2,240 pounds. The lowest price was £204 and the highest price was £342¼.[4]

WORLD'S OUTPUT.

The world's output of tin in 1919 is estimated to be 123,132 metric tons, a decline of about 4 per cent from the production of 1918. The figures given in the accompanying table are based mostly on official reports, and as far as possible are those of mine output, but for some countries, such as Bolivia, China, Siam, and Nigeria, they represent exports. The figures of output given in the original reports in terms of tin-bearing concentrate are here reduced to terms of metal obtainable by smelting. It is highly desirable in the interest of accuracy that the mineral statisticians of each tin-producing country report the output in terms of metallic tin. The aim of the table is to show the quantity of tin annually contributed to the world's supply by the mines of the chief tin-producing countries.

World's output of metallic tin, 1913–1919, in metric tons.

[Metal obtainable by smelting from concentrates.]

Country.	1913	1914	1915	1916	1917	1918	1919
Federated Malay States	50,930	49,820	47,520	44,570	40,470	37,970	37,460
British Protected Malay States	1,800	2,700	4,170	4,450	4,500	4,500	2,200
Bolivia	26,760	22,360	21,900	21,330	28,320	30,550	30,180
Banca	15,940	14,630	13,660	15,000	13,950	12,040	12,387
Billiton and Singkep	5,300	6,090	6,760	7,420	7,740	7,700	7,900
China	8,390	7,120	8,000	7,630	11,800	8,500	8,830
Siam	6,660	6,740	8,520	8,960	8,600	8,600	8,200
Nigeria	2,950	4,590	4,630	5,130	7,070	6,000	5,200
Australia	8,160	5,520	5,680	5,550	4,970	4,740	4,200
Cornwall	5,370	5,140	5,060	4,770	4,000	4,000	3,325
Union of South Africa	2,050	2,000	2,050	1,900	1,540	1,370	1,250
Other countries	1,400	1,500	1,500	1,700	1,800	2,000	2,000
	135,710	128,210	129,450	128,430	134,760	127,970	123,132

[3a] Metal Statistics, 1921, p. 355.
[4] Idem, p. 361.

GOLD, SILVER, COPPER, LEAD, AND ZINC IN COLORADO.

(MINES REPORT.)

By Charles W. Henderson.

PRODUCTION.

GENERAL SUMMARY.

The total gross calculated value of the gold, silver, copper, lead, and zinc produced in Colorado in 1919 showed a decrease of 37 per cent from the value of 1918. All the metals decreased in value except placer gold.

Metals were produced in Colorado from 453 deep and 11 placer mines in 1919, as compared with 576 deep and 12 placer mines in 1918. This decrease of 124 mines was chiefly in Chaffee, Lake, Ouray, San Juan, San Miguel, and Teller counties.

ORE.

In 1919 amalgamating and cyaniding mills, with or without concentration equipment (including all the custom mills of the State), treated 1,195,986 short tons of ore and made an average recovery of 0.289 ounce of gold and 0.203 ounce of silver to the ton. From this ore and from 439,373 tons sent to concentration and separation mills (85 per cent of the total quantity treated, as against 82 per cent in 1918), 100,775 tons of concentrates were produced, a ratio of 16.2 to 1.

The 11 productive placers yielded $550,562 in gold and 7,143 fine ounces of silver, valued at $8,000, a total of $558,562, as compared with $532,852 in 1918.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1918 and 1919.[a]

Year.	Number of producing mines.	Ore.	Gold.		Silver.[b]	Copper.	Lead.	Zinc.	Total value.
			Placer.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	588	2,314,890	$526,202	$12,225,516	7,063,554	6,277,332	65,960,760	89,133,901	$34,160,172
1919	464	1,919,768	550,562	9,336,065	5,758,010	3,560,207	37,070,241	37,220,493	21,679,614
Increase or decrease, 1919	−124	−395,122	+24,360	−2,889,451	−1,305,544	−2,717,125	−28,890,519	−51,913,408	−12,480,558

[a] A revised table showing the production of gold, silver, copper, lead, and zinc from the beginning of mining in Colorado to 1919 will be included in a professional paper, "The history and development of mining in Colorado, 1859–1919," now in preparation.

[b] Includes placer production.

GOLD.

The total production of gold is shown in the table on page 762.

The Cripple Creek district produced $5,827,816 in gold, its smallest output since 1894, but this represented 59 per cent of the State yield in 1919.

The San Juan region of Dolores, La Plata, Ouray, San Juan, and San Miguel counties yielded $2,338,871, a decrease of $163,933. Lake County yielded $625,956, a decrease of $217,283. There were also decreases of $54,311 in Chaffee, $139,950 in Clear Creek, $71,701 in Gilpin, $124,451 in San Juan, and $22,144 in San Miguel counties and increases of $66,381 in Park County and $8,752 in Summit County.

Summit County, with five dredges and five sluice mines, produced 84 per cent of the placer gold, and one dredge and one sluice mine in Lake County produced 15 per cent. The remainder came from hydraulicking and sluicing in Montrose and Park counties.

SILVER.

The yield of silver is given in the table on page 762. Thirteen counties showed decreases and five increases.

COPPER.

Of the output of copper in 1919 (see table, p. 762) San Miguel County produced 26 per cent; Lake County, 25 per cent; San Juan County, 19 per cent; and Dolores County, 7 per cent. Gilpin, Clear Creek, Eagle, and Ouray counties followed in order.

LEAD.

The production of lead is given on page 762. Only San Miguel and Park counties showed increases. In rank, Lake County was first, followed in order by San Miguel, San Juan, Pitkin, Ouray, Clear Creek, Mineral, Chaffee, Gilpin, Summit, Eagle, Park, and Boulder counties. All classes of ore yielding lead decreased in quantity and in lead content.

ZINC.

Of the zinc ores marketed from Colorado in 1919 (see p. 762), Lake County, with a decrease of 23,550,517 pounds, represented 62 per cent. Leadville shipments of zinc carbonate ore amounted to 16,542 tons, carrying 17.80 per cent of zinc; lead-zinc and zinc sulphide ores sold or treated in Leadville amounted to 46,967 tons, carrying 28.25 per cent of zinc. The production of zinc in Summit County was 4,047,096 pounds, and in Eagle County 3,367,548 pounds. The largest decreases were in Chaffee, Clear Creek, Eagle, Lake, San Juan, and Summit counties.

OUTPUT OF ORE AND METAL CONTENT.

Ore and metal produced in Colorado in 1919.

Source of production.	Ore.		Gold.		Silver.	
	Short tons.	*Per cent.*	*Fine ounces.*	*Per cent.*	*Fine ounces.*	*Per cent.*
Dry gold ore	1,111,640	57.91	396,354.31	82.87	724,260	12.58
Dry gold and silver ore	111,961	5.83	21,984.11	4.60	527,072	9.15
Dry silver ore	443,475	23.10	10,958.46	2.29	2,979,721	51.75
Copper ore	9,417	.49	4,992.49	1.04	104,381	1.81
Copper-lead ore	1,690	.09	339.40	.07	34,749	.60
Lead ore	74,918	3.90	10,205.10	2.13	1,068,360	18.56
Lead-zinc ore	116,120	6.05	6,717.87	1.41	283,741	4.93
Zinc ore	50,547	2.63	80.40	.02	28,583	.50
Total deep mines	1,919,768	100.00	451,632.14	94.43	5,750,867	99.88
Total placers			26,633.44	5.57	7,143	.12
Total, deep and placers, 1919	1,919,768	100.00	478,265.58	100.00	5,758,010	100.00
Total, deep and placers, 1918	2,314,890		616,864.36		7,063,554	
Decrease, 1919	395,122		138,598.78		1,305,544	

Source of production.	Copper.		Lead.		Zinc.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
Dry gold ore	905,068	25.42	4,113,337	11.10		
Dry gold and silver ore	266,154	7.48	3,181,276	8.58		
Dry silver ore	510,108	14.33	7,593,286	20.48		
Copper ore	774,435	21.75	58,466	.16		
Copper-lead ore	193,197	5.43	342,847	.93		
Lead ore	427,618	12.01	15,085,420	40.69		
Lead-zinc ore	483,627	13.58	5,837,855	15.75	21,079,069	56.63
Zinc ore			857,754	2.31	16,141,424	43.37
Total deep mines	3,560,207	100.00	37,070,241	100.00	37,220,493	100.00
Total placer mines						
Total, deep and placers, 1919	3,560,207		37,070,241		37,220,493	
Total, deep and placers, 1918	6,277,332		65,960,760		89,133,901	
Decrease, 1919	2,717,125		28,890,519		51,913,408	

Placer output in Colorado in 1919, in fine ounces.

County.	Sluice and hydraulic.		Dredges.		Total.	
	Gold.	Silver.	Gold.	Silver.	Gold.	Silver.
Lake	5.23	1	3,946.43	1,165	3,951.66	1,166
Montrose	9.63	2			9.63	2
Park	200.03	33			200.03	33
Summit	194.29	51	22,277.83	5,891	22,472.12	5,942
	409.18	87	26,224.26	7,056	26,633.44	7,143
Total, 1918	158.72	8	25,296.30	6,642	25,455.02	6,650
Increase, 1919	250.46	79	927.96	414	1,178.42	493

Content of dry gold ores sold or treated in Colorado in 1919.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	1,738	2,150.32	3,044	954	220
Clear Creek	2,952	1,489.52	12,445	13,539	101,450
Eagle	607	393.81	1,878	3,945	205
Gilpin	12,848	6,381.11	24,349	82,922	175,935
Gunnison	423	1,420.08	8,716	116	15,938
Lake	25,264	18,361.32	164,602	316,661	215,813
La Plata	271	273.21	2,508		81
Ouray	1,083	1,531.73	5,288	6,951	38,597
Park	889	2,846.19	2,458	4,320	70,156
San Juan	14,719	2,399.60	30,351	107,149	458,060
San Miguel	274,860	77,186.82	433,179	368,511	3,036,882
Teller	775,986	281,920.66	35,442		
	1,111,640	396,354.31	724,260	905,068	4,113,337

Content of dry gold and silver ores sold or treated in Colorado in 1919.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Clear Creek	7,473	1,633.74	35,930	76,103	319,599
Hinsdale	646	182.41	3,323	51	2,420
San Juan	16	40.96	772	.....	.....
San Miguel	103,826	20,127.00	487,047	190,000	2,859,257
	111,961	21,984.11	527,072	266,154	3,181,276

Content of dry silver ores sold or treated in Colorado in 1919.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	3,851	455.16	174,588	5,981	81,306
Chaffee	503	17.88	5,248	1,450	14,066
Clear Creek	100,834	340.65	220,827	4,224	242,982
Custer	3,976	215.77	73,889	4,146	65,535
Dolores	86	43.20	5,652	72	1,341
Eagle	3,114	163.55	40,710	110,840	12,654
Gilpin	1,645	254.90	10,810	14,708	65,248
Gunnison	3,509	102.21	7,168	3,417	24,325
Hinsdale	421	46.05	16,597	2,522	9,507
Lake	105,332	4,179.19	1,015,812	297,802	2,510,166
La Plata	134	15.39	3,567	167	2,202
Mineral	14,442	319.59	365,886	355	566,866
Ouray	61,531	2,826.06	501,137	10,748	1,135,976
Park	9,496	49.45	61,140	7,269	102,077
Pitkin	101,936	.....	311,423	.....	2,318,849
Routt	172	15.09	1,283	.....	.....
Saguache	48	4.13	6,399	311	3,276
San Juan	22	12.80	2,642	.....	.....
San Miguel	27,338	1,602.47	100,557	45,234	354,969
Summit	5,085	294.92	54,416	892	78,941
	443,475	10,958.46	2,979,721	510,108	7,593,286

Content of copper ores sold or treated in Colorado in 1919.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	8	10.40	33	1,126	.....
Chaffee	340	6.39	425	23,581	.....
Clear Creek	265	288.06	4,998	37,634	11,768
Custer	34	.20	1,644	3,647	2,407
Dolores	3,881	52.50	23,432	263,531	4,390
Eagle	112	326.60	988	8,521	.....
Gilpin	1,508	3,117.13	9,277	99,362	.....
Gunnison	14	3.50	38	1,250	.....
Hinsdale	13	5.20	363	1,956	90
Lake	1,999	903.74	40,874	156,416	11,426
Ouray	230	33.84	8,352	75,824	1,448
San Juan	979	231.90	13,049	99,220	25,900
San Miguel	34	13.03	908	2,367	1,037
	9,417	4,992.49	104,381	774,435	58,466
Total, 1918	18,088	1,968.68	166,296	1,668,087	169,957
Increase or decrease, 1919	−8,671	+3,023.81	−61,915	−893,652	−111,491

[a] All smelting ore.

Content of lead-copper ores sold or treated in Colorado in 1919.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Chaffee	144	3.71	1,835	11,370	89,540
Clear Creek	56	29.51	1,229	9,794	18,830
Custer	345	4.72	12,435	65,186	57,686
Gilpin	102	69.39	1,837	5,941	29,871
Hinsdale	30	2.70	423	1,756	13,220
Lake	653	16.33	10,506	75,923	76,968
San Juan	346	212.68	5,524	21,419	54,694
Summit	14	.36	960	1,808	2,038
	1,690	339.40	34,749	193,197	342,847
Total, 1918	1,760	198.17	35,260	138,132	309,041
Increase or decrease, 1919	−70	+141.23	−511	+55,065	+33,806

[a] All smelting ore.

Content of lead ores sold or treated in Colorado in 1919.

County.	Ore.	Gold.	Silver.	Copper.	Lead.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Boulder	546	27.96	47,819	2,982	122,079
Chaffee	2,625	1,116.02	20,119	4,184	375,521
Clear Creek	1,724	545.22	53,037	11,030	490,173
Custer	266	10.11	9,191	.....	29,506
Dolores	365	26.06	6,141	1,365	68,853
Gilpin	915	320.89	25,427	8,605	252,567
Grand	3	.05	508	.....	453
Gunnison	39	.73	884	341	13,199
Hinsdale	109	161.86	2,236	1,420	30,442
Lake	20,910	2,135.16	197,088	16,768	5,614,530
Mineral	59	4.70	1,138	.....	4,963
Ouray	1,098	66.77	110,886	15,341	541,244
Park	825	3,171.65	7,318	8,847	133,675
Pitkin	19,431	.....	345,635	.....	2,991,321
Saguache	461	35.39	31,368	36,033	49,239
San Juan	23,682	2,288.15	151,394	303,849	3,666,232
San Miguel	713	47.76	34,507	13,437	394,741
Summit	1,156	246.62	23,664	3,416	306,682
	74,918	10,205.10	1,068,360	427,618	15,085,420
Total, 1918	183,274	17,036.60	1,456,023	600,038	33,155,889
Decrease, 1919	108,356	6,831.50	387,663	172,420	18,070,469

Content of lead-zinc ores sold or treated in Colorado in 1919.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	15,090	1,669.83	12,923	30,238	324,101	499,658
Clear Creek	3,051	81.57	28,973	601	332,332	603,027
Dolores	129	.....	.....	.....	24,116	67,027
Gunnison	193	.....	1,619	.....	63,992	134,630
Lake	36,876	733.22	112,276	25,058	2,377,673	13,400,949
Mineral	2,226	115.10	2,581	.....	362,284	96,274
Ouray	523	8.45	1,996	3,324	65,603	23,343
San Juan	25,135	1,226.50	75,935	130,030	1,239,020	1,833,768
San Miguel	21,794	2,876.00	44,744	294,376	989,904	515,082
Summit	11,103	7.20	2,694	.....	58,830	3,905,311
	116,120	6,717.87	283,741	483,627	5,837,855	21,079,069
Total, 1918	291,196	4,832.99	570,130	268,684	14,003,753	64,718,334
Increase or decrease, 1919	−175,076	+1,884.88	−286,389	+214,943	−8,165,898	−43,639,265

[a] Nearly all concentrating ore.

Content of zinc ores sold or treated in Colorado in 1919.[a]

County.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Chaffee	953					465,972
Eagle	18,415	80.40	28,583		365,254	3,367,548
Gunnison	4,170					2,321,849
Lake	26,633				492,500	9,764,270
Pitkin	167					80,000
Summit	209					141,785
	50,547	80.40	28,583		857,754	16,141,424
Total, 1918	60,350	1,098.26	75,568	11,490	1,723,508	22,166,061
Decrease, 1919	9,803	1,017.86	46,985	11,490	865,754	6,024,637

[a] Nearly all smelting ore.

Gold and silver produced at mills in Colorado in 1919.

County.	Ore to gold and silver mills.	Gold in bullion.	Silver in bullion.	Ore to concentrating mills.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Short tons.*
Boulder	163	784.65	43	1,671
Chaffee				15,290
Clear Creek	1,212	371.78	90	111,058
Custer				572
Eagle				18,825
Gilpin	7,041	1,041.11	307	5,714
Gunnison				3,390
Hinsdale				500
Lake		1,810.82	587	27,522
Mineral				2,226
Ouray	35,558	37.00	95	26,128
Park				9,405
Pitkin			823	89,900
Routt				170
San Juan		14.14	1	62,050
San Miguel	376,076	65,588.86	208,426	51,742
Summit				13,210
Teller	775,936	276,387.20	31,897	
	1,195,986	346,035.56	242,269	439,373
Total, 1918	1,345,451	455,276.18	345,280	555,262
Decrease, 1919	149,465	109,240.62	103,011	115,889
Average content per ton		0.2893	0.2026	

Mine production of metals from Colorado concentrates in 1919.

By counties.

County.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	116	122.70	8,741	825	33,050	
Chaffee	1,170	1,673.77	14,016	30,344	326,719	499,658
Clear Creek	4,686	2,352.61	269,888	93,160	1,024,976	603,027
Custer	36		2,164		1,679	
Eagle	9,003	97.31	28,697		365,358	3,367,548
Gilpin	2,544	4,216.04	22,485	76,303	189,539	
Gunnison	215	83.40	3,419	3,312	17,455	
Hinsdale	24	29.44	941	51	2,420	
Lake	19,597	119.70	48,580	2,556	1,152,030	9,904,338
Mineral	517	115.10	2,581		362,284	96,274
Ouray	4,409	4,143.35	446,962	19,132	1,221,698	11,282
Park	485	42.19	57,584	7,117	98,247	
Pitkin	12,673		185,144		2,161,505	
Routt	17	15.09	1,061			
San Juan	9,836	5,741.71	163,905	495,351	4,705,805	1,801,664
San Miguel	26,863	36,203.43	857,101	898,121	7,241,012	515,082
Summit	5,206	47.76	6,928		110,844	3,905,311
Teller	3,378	5,255.00	3,524			
	100,775	60,258.60	2,123,721	1,626,272	19,014,621	20,704,184
Total, 1918	226,292	81,395.40	2,330,637	2,514,564	34,010,088	65,914,868
Decrease, 1919	125,517	21,136.80	206,916	888,292	14,995,467	45,210,684

Mine production of metals from Colorado concentrates in 1919—Continued.

By kinds of concentrates.

Class.	Concentrates.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry gold	6,977	11,250.92	40,867	72,418	88,970	.....
Dry gold and silver	121	121.50	1,888	6,448	9,353	.....
Dry silver	3,937	259.37	24,552	4,666	161,308	.....
Copper	42	49.24	356	6,902	.....	.....
Lead	50,737	43,513.24	1,860,871	1,075,586	15,773,556	.....
Copper-lead	3,327	3,733.37	57,437	272,858	1,050,215	.....
Total to copper and lead plants	65,141	58,927.64	1,985,971	1,438,878	17,083,402	.....
Zinc	11,048	23.33	23,554	.....	26,995	7,828,115
Lead-zinc	24,586	1,307.63	114,196	187,394	1,904,224	12,876,069
Total to zinc and lead-zinc plants	35,634	[a] 1,330.96	[a] 137,750	[a] 187,394	[b] 1,931,219	[c] 20,704,184
	100,775	60,258.60	2,123,721	1,626,272	19,014,621	20,704,184

[a] Recovered in zinc residues. [b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as metal and zinc in zinc oxide.

Average content.

	Gold.	Silver.	Copper.	Lead.	Zinc.
	Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry gold	1.61	5.86	0.52	0.64	.....
Dry gold and silver	1.00	15.60	2.66	3.86	.....
Dry silver	.07	6.24	.06	2.05	.....
Copper	1.17	8.48	8.22	.....	.....
Lead	.86	36.68	1.06	15.54	.....
Copper-lead	1.12	17.26	4.10	15.78	.....
Average	.90	30.49	1.10	13.11	.....
Zinc	.02	2.13	.....	.12	[d] 44.30
Lead-zinc	.05	4.64	.38	3.87	[d] 32.65
Average	.04	3.87	.26	2.71	[d] 37.58

[d] Assay of content; no deduction for loss in smelting.

Mine production of metals from Colorado crude ore shipped to smelters in 1919.

By counties.

County.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Boulder	4,309	1,736.49	216,700	10,218	173,555	.....
Chaffee	4,365	1,140.06	26,534	40,479	476,509	465,972
Clear Creek	4,085	1,683.88	87,461	59,765	492,158	.....
Custer	4,049	230.80	94,995	72,979	153,455	.....
Dolores	4,461	121.76	35,225	264,968	98,700	67,027
Eagle	3,423	867.05	43,462	123,306	12,755	.....
Gilpin	4,263	4,886.27	48,908	135,235	334,082	.....
Grand	3	.05	508	.....	453	.....
Gunnison	4,958	1,443.12	15,006	1,812	99,999	2,456,479
Hinsdale	719	368.78	22,001	7,654	53,259	.....
Lake	190,145	24,398.44	1,491,991	886,072	10,147,046	13,260,881
La Plata	405	288.60	6,075	167	2,283	.....
Mineral	14,492	324.29	366,994	355	571,829	.....
Ouray	2,779	286.50	180,602	93,056	561,170	12,061
Park	1,805	6,025.10	13,332	13,319	207,661	.....
Pitkin	31,634	.....	471,091	.....	3,148,665	80,000
Routt	2	.....	222	.....	.....	.....
Saguache	509	39.52	37,767	36,344	52,515	.....
San Juan	2,849	656.74	115,761	166,316	738,101	32,104
San Miguel	747	60.79	35,415	15,804	395,778	.....
Summit	4,357	501.34	74,806	6,086	335,647	141,785
Teller	50	278.40	21	.....	.....	.....
Total, 1918	284,409	45,337.98	3,384,877	1,933,935	18,055,620	16,516,309
	414,177	54,737.76	4,380,987	3,762,768	31,950,672	23,219,033
Decrease, 1919	129,768	9,399.78	996,110	1,828,833	13,895,052	6,702,724

Mine production of metals from Colorado crude ore shipped to smelters in 1919—Contd.

By kinds of ore.

Class.	Crude ore.	Gold.	Silver.	Copper.	Lead.	Zinc.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Dry gold	29,028	25,059.78	193,504	342,368	322,378	.....
Dry gold and silver	165	194.97	3,176	.....	.....	.....
Dry silver	149,884	6,266.25	1,975,154	437,406	3,502,971	.....
Copper	9,417	4,992.49	104,381	774,435	58,466	.....
Lead	52,879	7,866.87	1,008,104	163,762	12,009,574	.....
Copper-lead	1,690	339.40	34,749	193,197	342,847	.....
Total to lead and copper plants	243,063	44,719.76	3,319,068	1,911,168	16,236,236	.....
Zinc	31,599	.....	.....	.....	492,500	12,773,876
Lead-zinc	9,747	618.22	65,809	22,767	1,326,884	3,742,433
Total to zinc smelters and zinc oxide plants	41,346	[a] 618.22	[a] 65,809	[a] 22,767	[b] 1,819,384	[c] 16,516,309
	284,409	45,337.98	3,384,877	1,933,935	18,055,620	16,516,309

[a] Recovered in zinc residues.
[b] Lead recovered in zinc residues and leaded zinc oxide.
[c] Zinc recovered as metal and zinc in zinc oxide.

Average content.

	Gold.	Silver.	Copper.	Lead.	Zinc.
	Fine ounces per ton.	*Fine ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Dry gold	0.86	6.67	0.59	0.56	.....
Dry gold and silver	1.18	19.25	.....	.....	.....
Dry silver	.04	13.18	.15	1.17	.....
Copper	.53	11.08	4.11	.31	.....
Lead	.15	19.06	.15	11.36	.....
Copper-lead	.20	20.56	5.72	10.14	.....
Average	.18	13.66	.39	3.34	.....
Zinc	.....	.....	.....	.78	[d] 25.28
Lead-zinc	.06	6.75	.12	6.81	[d] 24.00
Average	.01	1.59	.03	2.20	[d] 25.00

[d] Assay of content; no deduction for loss in smelting.

Ore, concentrates, and tailings sent to amalgamation and cyanidation mills and gold and silver contained in bullion and precipitates in Colorado in 1919.

Process.	Quantity.	Gold in bullion.	Silver in bullion.	Quicksilver used.	Sodium cyanide used.
	Short tons.	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*
Amalgamation	753,232	138,727.72	27,378	4,540	.....
Cyanidation	[a] 954,421	207,307.84	214,891	.....	582,547
	.....	346,035.56	242,269	.....	.....

[a] Includes crude ore, concentrates, and also slimes and sands from amalgamating mills.

MINING INDUSTRY.

Shipments of bullion, ore, and concentrates from Colorado mines in 1919 contained in recoverable metals $9,886,627 in gold, 5,758,010 ounces of silver, 3,560,207 pounds of copper, 37,070,241 pounds of lead, and 37,220,493 pounds of zinc. After smelting and refining, these metals will have a calculated value at the average price for the

year of $21,679,614. Comparable figures for 1918 are $12,751,718 in gold, 7,063,554 ounces of silver, 6,277,332 pounds of copper, 65,960,760 pounds of lead, and 89,133,901 pounds of zinc, with a total calculated value of $34,160,172.

During 1919, as for several preceding years, none of the lead-copper smelting plants in Colorado were operated at full capacity. The Globe plant in April ceased to accept regular consignments of ore, but some special ores, flue dust, and other material were received from time to time to aid in disposing of stock on hand and for continuing the plant as a producer of arsenic. The Leadville, Pueblo, Durango, and Salida plants were all operated at reduced capacity.

The United States Zinc Co.'s zinc retort plant at Pueblo was operated at greatly reduced capacity. The River Smelting & Refining Co.'s plant at Florence continued to treat low-grade zinc-lead-copper ores from Colorado only. The Western Zinc Concentrating Co.'s plant at Leadville was operated at increased capacity on Leadville zinc carbonate ores, and the Ohio Zinc Co.'s zinc-oxide plant at Canon City was also operated at increased capacity on zinc carbonate ores from Colorado, Nevada, and Utah. The Empire Zinc Co.'s magnetic-separation mill at Canon City was operated steadily on Leadville zinc sulphide ores, but the Western Chemical Co.'s magnetic-separation wet-concentration mill, treating similar ores, was operated for only a part of the year, although the company's sulphuric acid plant was active on pyritic ores and also made some electrolytic zinc. Copper ore and matte and cyanide precipitate were shipped from Colorado to the smelter at Omaha and some copper ores were shipped to plants in Utah. The quantity of zinc ores shipped to zinc smelters and zinc oxide plants in Kansas, Oklahoma, and the Eastern States decreased heavily. Shipments of manganese, which had assumed considerable magnitude in 1918, ceased with the expiration of contracts on July 1, 1919.

Smelting plants in Colorado in 1919.

City.	Plant.	Owner.	Class of ore.	Product.	Total furnaces.[a]
Denver	Globe	American Smelting & Refining Co.	Lead base[b]	Lead bullion and copper matte.	7.
Pueblo	Pueblo	do	do	do	7.
Leadville	Arkansas Valley	do	do	do	10.
Durango	Durango	do	do	do	4.
Salida	Salida	Ohio & Colorado Smelting & Refining Co.	do	do	4.
Pueblo	United States Zinc Co.	American Smelting & Refining Co.	Zinc, lead, copper, gold, silver.	Zinc and zinc dust.	1,944 retorts.
Ouray	Crawford[c]	Ouray Smelting & Refining Co.	Pyritic copper	Copper matte	2.
Florence	Florence (Old Rocky Mountain).[d]	River Smelting & Refining Co.	Zinc, lead, copper, gold, silver.	Zinc oxide, lead sulphate, matte.	
Leadville		Western Zinc Concentrating Co.	Zinc carbonate	Zinc oxide	14 fire boxes.
Vulcan	Vulcan[c]	Vulcan Mines & Smelting Co.	Copper	Copper matte	1.
Canon City	Ohio	Ohio Zinc Co.	Zinc carbonate	Zinc oxide	Wetherill furnaces.

[a] Not all used.
[b] Copper ores and copper in other ores are handled by occasionally turning a lead furnace into a copper furnace.
[c] Idle.
[d] Intermediate plant of River Smelting & Refining Co., Keokuk, Iowa, for production of electrolytic zinc.

Cripple Creek produced $5,827,816 in gold in 1919, as compared with $8,119,747 in 1918, a decrease of $2,291,931. The Golden Cycle roast-cyanidation mill at Colorado Springs, which treats about 95 per cent of the high-grade ore shipped from Cripple Creek, was operated steadily except for a three weeks' shutdown during the coal strike in November, when it gave its coal to the city of Colorado Springs. In October the Vindicator washing and flotation mill at Victor was closed, so that less ore was available for the Golden Cycle mill. The Portland Independence cyanidation-concentration mill, at Victor, was the only mill actively operated throughout the year in the Cripple Creek district.

Lake County, chiefly Leadville, but including also the Lackawanna Gulch, Sugar Loaf, and St. Kevin lode districts and the Arkansas River dredge district, produced bullion and ores containing $625,956 in gold, 1,542,324 ounces of silver, 888,628 pounds of copper, 11,299,076 pounds of lead, and 23,165,219 pounds of zinc, having a total calculated value of $4,808,556, as compared with $843,239 in gold, 2,290,121 ounces of silver, 1,626,534 pounds of copper, 22,469,915 pounds of lead, and 46,715,736 pounds of zinc, having a total calculated value of $9,381,610, in 1918. Early in 1919 the low price of zinc and lead caused the Leadville operators to post a reduction of $1 a day in wages, which the miners met by a walkout, and the result was a cut of 50 cents a day in wages and the closing of several large properties. Company work at the long productive Western Mining Co.'s properties ceased at the end of 1918, but lessees assumed operation on part of this property. The Down Town Mines Co. continued operations throughout 1919.

Despite the removal of the pumps from the lower levels at Aspen early in the year there was a production of 657,058 ounces of silver and 5,310,170 pounds of lead, making an increase in silver but a heavy decrease in lead from that district.

In the San Juan region the Telluride district was the only one to maintain its production at normal, the output being $2,105,490 in gold and 1,100,942 ounces of silver, but the contemplated closing of the Liberty Bell mine and mill, which has been in continuous successful operation since 1896, foreshadows a decrease in production in that camp for 1920. The Tomboy Co., at Telluride, built a new mill, and the Smuggler Union Co. added to its plants during 1919, but the increase in the output of these companies must be considerable to equalize the loss of the Liberty Bell. At Silverton the production has been less than for several years. The fire which burned the Sunnyside office buildings and the miners' boarding and hotel buildings early in 1919 prevented that large producer from starting complete operation. The Iowas Tiger mill continued operations and made large production. At Ouray the Camp Bird Co. did much exploring work on the vein at the end of its new low-level adit but did not start milling. The Atlas and Mountain Top mines were in operation, and much development and some shipments were made at Red Mountain. Mines in La Plata County made very little production, although development work was done during the summer. Dolores County continued to ship copper ore from Rico, but no lead-zinc ore. Mineral County, which had pro-

duced at Creede a greatly increased quantity of silver in 1918, showed a considerable decrease in 1919, as one of the largest lessees abandoned work there and one of the other large properties was not so productive as in 1918. Production in Hinsdale County again dropped to desultory shipments of miscellaneous ore.

Early in 1919 the Wellington Co., at Breckenridge, found itself without a market for its zinc concentrates but continued operation for a few months, storing the concentrates. In September this company began shipping its stored concentrates and shipped also some iron-sulphide ores. The production of zinc from Summit County, which was 15,696,264 pounds in 1918, was only about one-third as much in 1919. Dredges in Summit County produced $460,524 in gold in 1919, as compared with $430,986 in 1918.

The zinc mines at Red Cliff, Eagle County, were active producers only during the early part of the year, but development was carried on during the last half of the year.

Production in Gunnison County was confined almost entirely to the zinc produced by the Doctor mine, on Spring Creek, from which there were increased shipments of zinc carbonate ore, and to small shipments of gold-silver ore from Iola and from Ohio City.

Boulder County increased its output of silver from 156,731 ounces in 1918 to 225,484 ounces in 1919, from the Yellow Pine at Sugar Loaf, the White Raven at Ward, and the mines at Caribou. The mines in Gilpin County were not active, and the closing of the Argo mill and its associated Tremont (Gunnell) mine at the end of the Argo adit reduced the production greatly. This county produced $209,683 in gold and 71,700 ounces of silver. The Becky Sharp mine produced considerable ore, and the Gilpin Eureka shipped amalgam bullion and concentrates.

In Clear Creek County the low price of lead and zinc closed the principal producing mines at Silver Plume in May and thus cut off the usual large silver contribution from that camp. There was a production from this county, however, of $91,127 in gold and 357,439 ounces of silver. Early in the spring the new Colorado Central mill, near Georgetown, increased its capacity and throughout the year contributed considerable silver in concentrates derived from the treatment of material from the Equator dump. The mills at Idaho Springs were not active in 1919, for the Argo and Jackson were closed and the Hudson and Newton were operated only on part capacity. The Little Mattie mill resumed operations at the end of the year.

Park County made appreciable increases in the output of gold and silver.

Mine production of gold, silver, copper, lead, and zinc in Colorado in 1919.

County.	Producing mines.	Ore sold or treated.	Gold.		Silver.	
			Quantity.	Value.	Quantity.	Value.
		Short tons.	*Fine ounces.*		*Fine ounces.*	
Boulder	46	6,143	2,643.84	$54,653	225,484	$252,542
Chaffee	9	19,655	2,813.83	58,167	40,550	45,416
Clear Creek	66	116,355	4,408.27	91,127	357,439	400,332
Custer	8	4,621	230.80	4,771	97,159	108,818
Dolores	7	4,461	121.76	2,517	35,225	39,452
Eagle	13	22,248	964.36	19,935	72,159	80,818
Gilpin	42	17,018	10,143.42	209,683	71,700	80,304
Grand	1	3	.05	1	508	569
Gunnison	14	8,348	1,526.52	31,556	18,425	20,636
Hinsdale	12	1,219	398.22	8,232	22,942	25,695
Lake	62	217,667	30,280.62	625,956	1,542,324	1,727,403
La Plata	12	405	288.60	5,966	6,075	6,804
Mineral	13	16,718	439.39	9,083	369,575	413,924
Montrose	1	.....	9.63	199	2	2
Ouray	23	64,465	4,466.85	92,338	627,659	702,978
Park	9	11,210	6,267.32	129,557	70,949	79,463
Pitkin	12	121,534	.....	.....	657,058	735,905
Routt	2	172	15.09	312	1,283	1,437
Saguache	5	509	39.52	817	37,767	42,299
San Juan	20	64,899	6,412.59	132,560	279,667	313,227
San Miguel	13	428,565	101,853.08	2,105,490	1,100,942	1,233,055
Summit	33	17,567	23,021.22	475,891	87,676	98,197
Teller	41	775,986	281,920.60	5,827,816	35,442	39,695
	464	1,919,768	478,265.58	9,886,627	5,758,010	6,448,971
Total, 1918	588	2,314,890	616,864.36	12,751,718	7,063,554	7,063,554
Decrease, 1919	124	395,122	138,598.78	2,865,091	1,305,544	614,583

County.	Copper.		Lead.		Zinc.		Total value.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	
	Pounds.		*Pounds.*		*Pounds.*		
Boulder	11,043	$2,054	206,605	$10,950	.....	.....	$320,199
Chaffee	70,823	13,173	803,228	42,571	965,630	$70,491	229,818
Clear Creek	152,925	28,444	1,517,134	80,408	603,027	44,021	644,332
Custer	72,979	13,574	155,134	8,222	.....	.....	135,385
Dolores	264,968	49,284	98,700	5,231	67,027	4,893	101,377
Eagle	123,306	22,935	378,113	20,040	3,367,548	245,831	389,559
Gilpin	211,538	39,346	523,621	27,752	.....	.....	357,085
Grand	.....	.....	453	24	.....	.....	594
Gunnison	5,124	953	117,454	6,225	2,456,479	179,323	238,693
Hinsdale	7,705	1,433	55,679	2,951	.....	.....	38,311
Lake	888,628	165,285	11,299,076	598,851	23,165,219	1,691,061	4,808,556
La Plata	167	31	2,283	121	.....	.....	12,922
Mineral	355	66	934,113	49,508	96,274	7,028	479,609
Montrose	.....	.....	.....	.....	.....	.....	201
Ouray	112,188	20,867	1,782,868	94,492	23,343	1,704	912,379
Park	20,436	3,801	305,908	16,213	.....	.....	229,034
Pitkin	.....	.....	5,310,170	281,439	80,000	5,840	1,023,184
Routt	.....	.....	.....	.....	.....	.....	1,749
Saguache	36,344	6,760	52,515	2,783	.....	.....	52,659
San Juan	661,667	123,070	5,443,906	288,527	1,833,768	133,865	991,249
San Miguel	913,925	169,990	7,636,790	404,750	515,082	37,601	3,950,886
Summit	6,086	1,132	446,491	23,664	4,047,096	295,438	894,322
Teller	.....	.....	.....	.....	.....	.....	5,867,511
	3,560,207	662,198	37,070,241	1,964,722	37,220,493	2,717,096	21,679,614
Total, 1918	6,277,332	1,550,501	65,960,760	4,683,214	89,133,901	8,111,185	34,160,172
Decrease, 1919	2,717,125	888,303	28,890,519	2,718,492	51,913,408	5,394,089	12,480,558

REVIEW BY COUNTIES.

BACA COUNTY.

No shipments were made in 1919 from the copper deposits in the Carrizo district, in the southwest corner of Baca County.

BOULDER COUNTY.

Mine production in Boulder County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	27	10,387	$52,265	156,731	17,887	262,310	$232,038
1919	46	6,143	54,653	225,484	11,043	206,605	320,199
Increase or decrease, 1919	+19	−4,244	+2,388	+68,753	−6,844	−55,705	+88,161

Central district.—The production of the Central district (near Jamestown) was 305 tons of smelting ore, carrying $17,640 in gold, 1,850 ounces of silver, 280 pounds of copper, and 19,623 pounds of lead, with a total value of $20,804, as compared with $8,089 in 1918. The greater part of the production came from the Black Rose, Wano, and Smuggler mines. The remainder was from small lots of ore found in pockets in mining for fluorspar.

Gold Hill district.—The production of the Gold Hill district was 1,526 tons of ore, carrying $7,684 in gold, 20,500 ounces of silver, 1,479 pounds of copper, and 2,359 pounds of lead and having a total value of $31,044, as compared with $28,532 in 1918. The most productive property was the Victoria, from which several cars of high-grade silver ore were shipped. The 50-ton table-concentration and oil-flotation mill, operated on dump ores of the Slide mine in 1918, was operated only 75 days in the spring of 1919 and then closed. Other producing mines were the Baron group, Interocean, Melvina, Nil Desperandum, Prussian, and Tippecanoe.

Grand Island district (*Cardinal, Caribou, and Eldorado.*)—The Grand Island district in 1919 produced 1,312 tons of ore, carrying $6,071 in gold, 75,025 ounces of silver, 1,349 pounds of copper, and 25,189 pounds of lead, and having a total value of $91,685, as compared with $33,471 in 1918. The principal producing mine was the Caribou, from which considerable high-grade silver ore was shipped to the smelter. Other producing mines of importance were the Belcher, Blue Bird, Boulder County, Congo Chief, Maine, Poorman, and Potosi.

Magnolia district.—Several small lots of ore, from the Magnolia district aggregating only 19 tons, were sold or treated in 1919.

Sugar Loaf district.—The Sugar Loaf district became the principal producing district in the county in 1919, with a yield of 2,038 tons, carrying $22,662 in gold, 87,892 ounces of silver, 7,935 pounds of copper, and 39,302 pounds of lead and having a total value of $124,660, as compared with $79,831 in 1918. The principal producing mines were the Yellow Pine, from which silver ore was

shipped to smelters by lessees; and the Logan mine, from which some gold smelting ore to smelters and considerable gold bullion in small lots from high-grade pockets was shipped to the Mint. Other properties in the district produced small lots of gold specimens and gold smelting ore.

Ward district.—The Ward district in 1919 produced 943 tons of ore, carrying $326 in gold, 40,075 ounces of silver, and 120,132 pounds of lead and having a total gross value of $51,577, as compared with $82,115 in 1918. The principal producing mine was the White Raven. Much high-grade silver ore was shipped from this mine direct to the smelter, and the 20-ton concentration mill, completed in October, was operated during the rest of the year on dump ores, yielding several cars of high-grade lead-silver concentrates. Small lots of ore were mined in this district from the Blue Coat, Celestial, and Moltke.

CHAFFEE COUNTY.

Mine production in Chaffee County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	21	39,598	$112,478	81,187	323,830	1,885,761	2,618,769	$645,848
1919	9	19,655	58,167	40,550	70,823	803,228	965,630	229,818
Decrease, 1919	12	19,943	54,311	40,637	253,007	1,082,533	1,653,139	416,030

Chalk Creek district.—The Mary Murphy mine continued to be the most productive in the county, despite the fact that the mine was closed June 1, 1919, except for small leasing operations in the upper levels. The Mary Murphy mill was operated until November 1. The Paramount Reduction Co. completed during the year a 75-ton concentration mill and operated it for 2½ months on stored ore from the Flora Belle mine. This trial operation resulted in the decision that the mill was unsatisfactory. The development work at the Flora Belle consisted of the erection of an aerial tram and the completion of a 400-foot crosscut tunnel. The work at the Allie Belle mine consisted of development for 11 months, and several cars of silver sulphide ore, removed in driving the drifts, were shipped to the smelter at Salida.

Cleora district.—All the prospects in the Cleora district were idle in 1919.

Cottonwood and South Cottonwood districts (Buena Vista).—Development work was done at the Eureka Mountain mine and at the Gladstone mine.

Monarch (Garfield) district.—From 6 mines in the Monarch district 2,610 tons of ore was shipped, carrying $1,241 in gold, 9,575 ounces of silver, 16,645 pounds of copper, 340,190 pounds of lead, and 465,972 pounds of zinc and having a total gross value of $67,107, as compared with $195,360 in 1918. The two principal producing mines were the Eclipse and the Madonna, from which oxidized ores

both of lead and zinc were shipped. Other producing mines were the Columbus, Garfield, Hawkeye, and New York.

Riverside district (Buena Vista).—Development work was done at the Mount Harvard mine.

Turret district (including Sedalia).—Several cars of copper oxidized ore were shipped from the Sedalia mine and one car of copper oxidized ore from the Independence mine.

CLEAR CREEK COUNTY.

Mine production in Clear Creek County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	59	57,808	$231,077	370,888	343,247	3,869,352	1,812,846	$1,126,440
1919	66	116,355	91,127	357,439	152,925	1,517,134	603,027	644,332
Increase or decrease, 1919	+7	+58,547	−139,950	−13,449	−190,322	−2,352,218	−1,209,819	−482,108

Alice (Yankee) district.—Small lots of gold ore from the Clara, Gold Anchor, Meteor, and Reynolds mine, treated in a small amalgamation-concentration mill in the Alice district, yielded in bullion and concentrates $1,548 in gold and 33 ounces of silver.

Argentine district.—The Argentine district in 1919 produced from 6 mines 836 tons of ore, carrying $5,040 in gold, 5,975 ounces of silver, 34,441 pounds of copper, and 37,359 pounds of lead and having a total value of $20,118, as compared with $11,483 in 1918. The Josephine mill was operated for a short period on ore from the dump. Some development work was done at the Santiago mine, and one block of ground was stoped, yielding several hundred tons of copper sulphide ore, assaying well in gold and silver. During the last three months of the year the pioneer Consolidated Mining Co. leased the Waldorf mine and mill and sent through the mill a considerable quantity of gold-silver ore. The Centennial-Stevens mine was operated both on company and lessee account, with one shipment of lead-silver sulphide ore.

Empire (Upper Union) district.—The Bellevue-Hudson mine, was the only producer near Empire. Lessees on this property shipped lead sulphide ore to the Argo concentration mill at Idaho Springs and to smelters. Development work was continued at the properties of the Golden Empire Co. In the Daily district, beyond Empire, toward Berthoud Pass, the Argo Leasing Co., on the Doctor Towne mine, employed an average of five men for five months in development work and operated the 50-ton concentration mill for a few days in order to test the machinery and process.

Geneva Creek (Collier Mountain) district.—Development work was continued in the reopening of the Gilman-Treasure Vault group, Sill, and Silver Queen properties, in the Geneva Creek district, which is reached by way of Hall Valley from Grant, Park County.

Griffith (Georgetown, Silver Plume) district.—The Georgetown-Silver Plume district in 1919 produced from 11 mines 101,713 tons of ore, yielding $4,507 in gold, 226,934 ounces of silver, 4,656 pounds of copper, 629,830 pounds of lead, and 603,027 pounds of zinc, with a total value of $336,941, as compared with $414,311 in 1918.

South of Georgetown, on South Clear Creek, the Colorado-Central 250 to 400 ton flotation mill (built and set in motion late in 1918) was operated continuously, treating nearly 100,000 tons of silver-bearing material from the Ocean Wave dump. The Capital amalgamation-concentration mill, at Georgetown, was idle, but the Capital Co. employed an average of 10 men throughout the year on development work, and lessees mined and shipped several cars of lead sulphide ore. From the Sceptre mine, on Colorado, Republican, and Democrat mountains, lessees in the course of desultory drifting mined and shipped several cars of milling and smelting silver ore.

At Silver Plume the Wasatch-Colorado Mining Co. employed an average of 13 men throughout the year on development work at the Mendota-Frostburg mine. The 75-ton wet-concentration mill of this company was operated for a short time, with a product of lead-silver concentrate and zinc concentrate. The Denbigh Silver Lead Mines Co., engaged in reopening and developing the Terrible Dunderberg group, employed a large force of men for the first four months of the year but cut the force to a few men for the remaining eight months. During the early part of the year this company shipped several hundred tons of lead-zinc ore for concentration and separation to the Newton mill at Idaho Springs. At the Smuggler mine stoping of blocked out ore was continued steadily for the first four months of the year, after which the mine was closed. This ore was shipped to the Newton mill at Idaho Springs, with product of lead-silver concentrate and zinc concentrate carrying some lead and silver. The Nashotah mill, at Silver Plume, idle for many years, was reopened in the spring, and several hundred tons of silver ore was milled from the Corry City-Wisconsin-Diamond Tunnel group. Just above the Georgetown loop of the Colorado & Southern Railroad the Wide West Mining Co., for the first four months only, continued construction work and some driving at its crosscut adit, known as the Hall tunnel. This adit runs southeastward toward Leavenworth Mountain and when work ceased was 3,000 feet long.

Idaho Springs district.—The Idaho Springs district includes the mines about Idaho Springs, the Banner, Cascade, Coral, Jackson, Lower Fall River, Payne's Bar, and Spanish Bar, and Virginia Canyon subdistricts. In 1919 this district produced 11,568 tons of ore, as compared with 33,339 tons in 1918. The production of metals was $70,787 in gold, 89,709 ounces of silver, 100,618 pounds of copper, and 640,001 pounds of lead, having a total value of $223,896, as compared with $585,568 in 1918. Of the ore mined in 1919 only 686 tons was treated at amalgamating mills (having also concentration equipment) and yielded 304.94 fine ounces of gold and 70 ounces of silver, and 7,820 tons was treated at mills for concentration only, a total to both classes of mills of 8,506 tons, which produced 2,056 tons of concentrates, carrying 1,949.72 fine ounces of gold, 41,903 ounces of silver, 81,963 pounds of copper, and 408,309 pounds of lead. Crude ore shipped to smelters amounted to 3,062 tons of ore,

carrying 1,169.66 fine ounces of gold, 47,736 ounces of silver, 18,655 pounds of copper, and 231,692 pounds of lead.

At the mouth of the Argo tunnel the Argo 20-stamp gravity and oil-flotation mill was operated at reduced capacity until May 1, when the plant was closed. During the four months of operation 72 per cent of the ore treated was from Gilpin County and the remainder from Clear Creek County, and Gilpin County contributed 79 per cent of the gold and 46 per cent of the silver. The Newton mill was operated steadily on custom ore to December 1. The only other operating custom mill was the Hudson. The Combination mill was operated for a short period.

In Gilson Gulch lessees continued operations at the Franklin mine. Through the Argo (Newhouse) tunnel the Gem mines continued to be one of the principal producing properties in the district. From the Tremont (Gunnell) and Concrete mines in Gilpin County, operated through the Argo tunnel, considerable ore was shipped until May 1 to the Argo mill. From mines in Gilpin County, owing to the idleness of mills in that county, much ore was hauled by wagon and railroad to mills at Idaho Springs. In Virginia Canyon small outputs were made from the Bellevue-Champion, Calvin, Crown Point, and Victor. The Specie Payment mine, opened through the Two Brothers adit, in Virginia Canyon, was operated during the first six months of the year. Through the Big Five tunnel lessees operating the Edgar shipped much ore to various mills. On the south side of Clear Creek there was a small output from the Little Mattie, considerable ore was shipped from the Lord Byron mine, and lessees shipped some ore from the Stanley mine. Farther up Chicago Creek several hundred tons of silver ore was shipped from the Black Eagle mine. From the Argo mine, on Ute Creek, a small lot of high-grade silver ore was shipped.

Montana (Lawson, Dumont) district.—The Montana district from 6 mines produced 1,028 tons of ore, yielding $3,373 in gold, 13,175 ounces of silver, 6,694 pounds of copper, and 38,415 pounds of lead and having a total value of $21,410, as compared with $42,133 in 1918. From the Albro mine, at Dumont, several cars of gold ore were shipped to mills at Idaho Springs and to the Globe smelter. From the Blue Ridge-Senator mine a considerable quantity of gold-silver ore was shipped to the Newton mill, at Idaho Springs, and several cars of lead-silver ore were shipped to smelters. Other producing mines were the Great Britain and Portland. From the Jo Reynolds mine, at Lawson, several cars of lead-silver ore containing a very high content in silver were shipped to the smelter. In the course of development work carried on steadily at the Two American Sisters mine small shipments of milling and smelting ores were made.

Trail Creek (Lamartine and Freeland) district.—The Trail Creek district from 4 mines produced 583 tons of ore, yielding $3,683 in gold, 4,750 ounces of silver, 3,758 pounds of copper, and 123,472 pounds of lead, and having a total gross value of $16,246, as compared with $60,297 in 1918. Lessees on the Freeland-Turner group shipped lead-silver sulphide ore to mills and smelters, and lessees on the Lamartine mine shipped silver ore to the sampling works and to smelters. Several lots of gold-silver ore were shipped from the Gum Tree mine.

CUSTER COUNTY.

Mine production in Custer County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	12	4,326	$4,341	108,456	51,292	281,070	13,516	$146,652
1919	8	4,621	4,771	97,159	72,979	155,134	.....	135,385
Increase or decrease, 1919	−4	+295	+430	−11,297	+21,687	−125,936	−13,516	−11,267

The bulk of the ore shipped from Custer County in 1919 was dry silver ore; the remainder was lead sulphide and oxide, lead-copper oxide, and copper sulphide. The Maxine Elliott, Black Friday, Buffalo Hunter, and Passiflora were the principal producing mines. The Buffalo Hunter Mining, Milling & Development Co., with leases on the Geyser, Buffalo-Hunter, and Boulder properties, was organized in 1916 to determine the most effective process for producing a high-grade manganese product from its low-grade manganese-silver ores. A 15-ton concentration mill was practically completed July 15, 1918, and further experimentation was conducted during the remainder of the year. The price of manganese declined so rapidly after the end of the war that the original plan was abandoned early in 1919 and operations were continued in a desultory manner by careful sorting of the ore for milling until October 15, when work ceased.

DENVER COUNTY.

The Globe lead-copper smelter, which for years has treated ores from Colorado, Idaho, Utah, British Columbia, and Canada, in April ceased to accept ores for smelting but was continued as an arsenic plant, treating arsenic bearing ores and flue and bag-house dust from other smelters. The Western Chemical Manufacturing Co.'s sulphuric acid plant and electrolytic experimental zinc plant were operated on pyritic and lead-zinc ores for only a few months, and later operations were restricted to the roasting of pyritic ores for the manufacture of sulphuric and related acids. There are many small ore-testing and experimental plants in Denver.

DOLORES COUNTY.

Mine production in Dolores County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	9	9,272	$3,136	54,249	618,012	517,394	661,253	$306,943
1919	7	4,461	2,517	35,225	264,968	98,700	67,027	101,377
Decrease, 1919	2	4,811	619	19,024	353,044	418,694	594,226	205,566

Lone Cone (Dunton) district.—The activities of the Silver Gulch Mining & Milling Co. at the Rosebud mine included some underground development work but consisted principally in surface improvements, including construction of a sawmill, roads, boarding house, and office, freighting from the railroad the machinery for a 50-ton flotation mill, and the partial completion of a railroad grade for a spur from the mine to the Rio Grande Southern Railway.

Pioneer (Rico) district.—The Pioneer is the principal producing district in Dolores County. There is a considerable variety of ores in the district, including pyritic, zinc-lead, lead, and copper sulphides. In 1919 the bulk of the ore shipped was copper sulphides, chiefly the result of operations by the Marmatite Mining & Milling Co., lessee on the Black Hawk and other mines.

DOUGLAS COUNTY.

The E. I. du Pont de Nemours powder plant at Louviers continued to use some Leadville pyritic ores for their sulphur content.

EAGLE COUNTY.

Mine production in Eagle County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	19	89,675	$35,975	241,406	353,041	2,927,099	14,845,341	$1,923,332
1919	13	22,248	19,935	72,159	123,306	378,113	3,367,548	389,559
Decrease, 1919.	6	67,427	16,040	169,247	229,735	2,548,986	11,477,793	1,533,773

Battle Mountain (Red Cliff) district.—Much development work was done at the mines of the Empire Zinc Co., and during part of the year the 170-ton magnetic separation mill at the mine was operated and made zinc concentrates, iron-zinc middlings, and some lead concentrates. From this property was also shipped pyritic silver ore. The Pine Martin concentration mill was operated for a short time on ores from the dump of the Ground Hog mine. Other producing mines were the Alpine, Ben Butler, Horn Silver, Little Courteney, Mabel (Pursey Chester), T. P. M., and Wyoming Valley.

Brush Creek district.—One car of silver ore was shipped from the Lady Belle-North Dakota group.

Holy Cross district.—Reworking of old dumps in the Holy Cross district yielded 1 ton of gold concentrates.

EL PASO COUNTY.

At Colorado Springs are the Golden Cycle 1,200-ton and Portland 400-ton cyanidation mills, which in the past have treated almost exclusively (with the exception of those mills at Victor treating low-grade ores) the ores of the Cripple Creek district, Teller County. In 1919 the Portland mill was idle and the Golden Cycle mill was not operated to capacity.

FREMONT COUNTY.

No ores were shipped from Fremont County in 1919, but at the Gumaer (Cotopaxi) mine a considerable force of men was employed throughout the year in the construction of a concentration mill.

At Canon City are the Ohio Zinc Co.'s zinc oxide plant and the Empire Zinc Co.'s magnetic separation plant, both of which were operated steadily in 1919. At the River Smelting & Refining Co.'s matting and fuming plant, Florence, lead sulphate and zinc oxide are made preliminary to electrolytic treatment at Keokuk, Iowa.

GILPIN COUNTY.

Mine production in Gilpin County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	51	23,654	$281,384	124,929	456,044	774,972	28,099	$576,536
1919	42	17,018	209,683	71,700	211,538	523,621	.....	357,085
Decrease, 1919	9	6,636	71,701	53,229	244,506	251,351	28,099	219,451

Southern districts (Blackhawk, Central City, Nevadaville, Russell Gulch).—Amalgamating and concentration mills in the southern districts were nearly all idle in 1919. The Iron City custom concentration mill was operated for a few months only, the Polar Star amalgamation-concentration mill was operated intermittently, and the Eureka amalgamation-concentration mill was operated steadily for 10 months on Eureka ores only. Within the limits of the town of Central City no mines were active.

In the Enterprise district, below Blackhawk, lead-silver ore from the Wheeler (Bryan Tunnel) mine was shipped to smelters and to Idaho Springs mills. The Black Jack mine was reopened and several cars of high-grade silver-lead ore were shipped to smelters.

Producing mines in the district embracing Gunnell Hill and Eureka and Prosser gulches were the Concrete, Eureka, and Gunnell. The Concrete and Gunnell mines were operated by the Tremont Co. (subsidiary of the Argo Ore Purchasing & Reduction Co.), and with the closing of the Argo mill in May, all operations ceased at these mines.

Production in the district embracing the town of Blackhawk and Gregory, Bobtail, and Bates hills was confined to small lots of ore from the Gilpin-Orion, Homer, Klein-German, and Running Lode mines.

Mines in the district embracing Illinois and Leavenworth gulches and the eastern portion of Quartz Hill were idle.

Producing mines in the Lake Gulch district were the East Notoway and Vivian-Notoway.

In the vicinity of Nevadaville the producing mines were the East Missouri, Hubert, and Kansas-Burroughs.

In the Quartz Valley district the only producing mine was the Gold Cup.

In the Russell Gulch district producing mines were the Becky Sharpe, Big Six, Chase, Druid, Fairfield, Frontenac, Hampton, Incidental, and Lillian.

In the Hughesville-Hawkeye district, just north of Blackhawk, some development work was done in reopening old silver properties.

Northern districts.—In the Silver Creek district, near Apex, development was continued at the Reform group by the Cornucopia Co., and some ore was milled in the amalgamation-concentration plant on the property. Development work was continued at the Evergreen mine at Apex.

In the Independence district the Perigo mines and mill were operated and the Smuggler mine and mill were operated for short periods.

In the Vermilion district mill tests on ore from the North Star mine yielded a small quantity of bullion and concentrates.

GRAND COUNTY.

A small lot of high-grade silver ore was shipped from the Ready Cash mine, across the range from Empire.

GUNNISON COUNTY.

Mine production in Gunnison County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	14	6,344	[a] $10,368	12,880	43,033	300,760	2,349,538	$269,039
1919	14	8,348	31,556	18,425	5,124	117,454	2,456,479	238,693
Increase or decrease, 1919	.....	+2,004	+21,188	+5,545	−37,909	−183,306	+106,941	−30,346

[a] Includes placer production.

Cebolla district (*Vulcan, Domingo*).—During the first eight months of the year lessees on the Good Hope mine shipped several cars of ore carrying a high content of gold and silver. A car of copper sulphide ore was shipped from the Headlight mine.

Elk Mountain district.—Lessees operating the Doctor mine, on Spring Creek, from January through November, shipped a large quantity of zinc carbonate ore. Several cars of silver ore were shipped from the Excelsior-Yankee Blade mine, near Crested Butte. From June through November development work in the form of 75 feet of shaft and 30 feet of crosscuts was done at the Ruby King-Forest Queen group of mines.

Gold Brick district (*Ohio City*).—Lessees on the Carter group of mines shipped several hundred cars of gold-silver ore. Spasmodic work at the Queen mine resulted in the shipment of one small lot of silver ore.

Quartz Creek district (*Pitkin*).—Operation of the Penn Molybdenum Mines Co.'s concentration mill resulted in the shipment of several cars of silver-gold concentrates.

Tincup district.—Two cars of silver ore were shipped from the El Capitan mine.

Tomichi district (Whitepine).—At the property of the Akron Mines Co. light development work was carried on continuously at the mine and the remodeling of the milling plant started in 1918 was continued and completed. The mill was operated in September and October. A small car of silver ore was shipped from the Prescott mine. Development work was continued at the Victor mine and some lead and lead-zinc ore was shipped.

HINSDALE COUNTY.

Mine production in Hinsdale County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	18	5,222	$6,249	22,245	18,308	767,972	$87,542
1919	12	1,219	8,232	22,942	7,705	55,679	38,311
Increase or decrease, 1919	−6	−4,003	+1,983	+697	−10,603	−712,293	−49,231

Galena district.—Lessees on the Excelsior mine shipped two cars of lead-copper ore to the Pueblo smelter. Considerable development work was done on the Golconda mine, and several cars of good-grade gold-silver ore were shipped. A small car of high-grade silver ore was shipped from the Varden Belle mine. The Hidden Treasure mine and mill were idle, the only work done being repairs to the pipe line for the power plant.

Lake district.—Silver ore was shipped from the Cleveland, Cora-Sulphuret, Fanny Fern, Gladiator, and Pelican mines. Several cars of good-grade gold-silver ore were shipped from the Ilma-Hiwassee mine. A car of lead-silver ore was shipped from the Lellie mine. The operation of reopening the long idle Golden Fleece mine was continuous throughout the year, consisting of the installation of new machinery in the concentration mill, the construction of a hydroelectric plant, and the driving of drifts to facilitate the removal of old waste material from the stopes for treatment at the mill.

JEFFERSON COUNTY.

Prospecting and development work were continued on the old Malachite property, lying between Bear Creek and Mount Vernon.

LAKE COUNTY.

Mine production in Lake County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.		Silver.[a]	Copper.	Lead.	Zinc.	Total value.
			Placer.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	92	355,840	$92,066	$751,173	2,290,121	1,626,534	22,469,915	46,715,736	$9,381,610
1919	62	217,667	81,688	544,268	1,542,324	888,628	11,299,076	23,165,219	4,808,556
Decrease, 1919	30	138,173	10,378	206,905	747,797	737,906	11,170,839	23,550,517	4,573,054

[a] Includes placer production.

In Lake County the production of all metals, particularly zinc, showed heavy decreases. The quantity of ore under discussion in this report (not including the iron-manganese ore used in the steel industry) mined in 1919 was 138,173 tons less than in 1918. The greatest decrease in 1919 was in zinc-lead sulphide ores; the only increase was in iron-manganese-silver flux ores (the result of the curtailment of purchases by the steel mills from properties which had opened and developed this class of ore during 1917 and 1918).

This county continued to rank first in the production of silver, lead, and zinc but gave way to San Miguel County in the production of copper; in the production of gold it again ranked third, following Teller and San Miguel. Of the State total, Lake County produced 6 per cent of the gold, 27 per cent of the silver, 25 per cent of the copper, 30 per cent of the lead, and 62 per cent of the zinc.

The Derry Ranch dredge, at the mouth of Rock Creek, on Arkansas River 12 miles below Malta, continued operations except during the severe winter months. This dredge began operations in 1915.

LEADVILLE DISTRICT.

GENERAL FEATURES.

Of the 217,667 tons mined in Lake County 216,560 tons was from the Leadville district. The yield was $541,809 in gold, 1,498,133 ounces of silver, 887,177 pounds of copper, 11,276,491 pounds of lead, and 23,165,219 pounds of zinc, and the value was $4,673,448 out of a county total of $4,808,556. In 1918 the value was $9,180,062 out of a county total of $9,381,610.

Classification of Leadville ores in 1919.

Character.	Quantity.	Percentage.
	Short tons.	
Sulphide:		
Siliceous sulphide (carrying pyrite)[a]	24,445	11
Zinc-iron-lead (zinc blende, pyrite, and galena)	46,967	22
Iron (pyrite with gold, silver, copper, and lead, and some zinc blende)[a]	66,500	31
	137,912	64
Oxide:		
Lead-copper	653	.....
Lead (iron excess)	1,087	.....
Lead (siliceous excess)	18,916	09
Copper (siliceous excess)	139	.....
Iron flux	1,726	01
Iron-manganese flux	33,341	15
Siliceous	6,244	03
Zinc	16,542	08
	78,648	36
Grand total	216,560	100

[a] The greater part of the pyrite carries iron in excess of silica and also high silver but low gold content. A large quantity of pyrite carries silica in great mass over iron and of greater value than the silver. Some of the pyrite approaches the zinc-iron-lead classification (when zinc market gives higher returns or sale as lead-zinc sulphide than as lead sulphide to lead smelters), and vice versa.

Classification of Leadville ores in 1919—Continued.

Character.	Quantity.	Recovered content.				
		Gold.	Silver.	Copper.	Lead.	Zinc.
Sulphide:	*Short tons.*	*Fine ounces.*	*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*
Lead siliceous	907	1,064.91	18,647	11,622	216,427	
Copper siliceous	1,860	903.74	40,764	137,600	11,426	
Iron pyrites[a]	66,500	3,733.70	664,276	283,875	1,547,598	
Siliceous sulphide (carrying pyrite)	21,678	13,935.90	150,472	308,658	132,076	
Zinc-iron-lead	46,967	[b] 733.22	[b] 112,276	[b] 25,058	[b] 2,870,173	[c] 18,573,049
Oxide:						
Lead-copper	653	16.33	10,506	75,923	76,968	
Lead (iron excess)	1,087	10.50	5,624		172,702	
Lead (siliceous excess)	18,916	1,059.75	172,817	5,146	5,225,401	
Copper (siliceous excess)	139		110	18,816		
Iron flux	1,726	85.50	7,063		39,388	
Iron-manganese flux	33,341	86.41	259,865	1,985	842,365	
Siliceous	6,244	2,769.23	55,126	18,494	141,967	
Zinc	16,542					[c] 4,592,170
Metallics (sulphide and oxide)[d]		1,810.82	587			
	216,560	26,210.01	1,498,133	887,177	11,276,491	23,165,219

Character.	Average recovery.				
	Gold.	Silver.	Copper.	Lead.	Zinc.
Sulphide:	*Ounces per ton.*	*Ounces per ton.*	*Per cent.*	*Per cent.*	*Per cent.*
Lead siliceous	1.17	20.56	0.64	11.93	
Copper siliceous	.49	21.92	3.70	.31	
Iron pyrites	.06	9.99	.21	1.16	
Siliceous sulphide (carrying pyrite)	.64	6.94	.71	.30	
Zinc-iron-lead	[e] .03	[e] 4.11		[e] 5.52	[f] 28.25
Oxide:					
Lead-copper	.03	16.09	5.81	5.89	
Lead (iron excess)	.01	5.17		7.94	
Lead (siliceous excess)	.06	9.14	.01	13.81	
Copper (siliceous excess)		.79	6.73		
Iron flux	.05	4.09		1.14	
Iron-manganese flux		7.79		1.26	
Siliceous	.44	8.83	.15	1.14	
Zinc					[f] 17.80
Metallics (sulphide and oxide)					

[a] Includes both ore to lead plants and ore used for making sulphuric acid from which residues were returned to lead plants.
[b] Recovered as lead and iron concentrates in zinc residues.
[c] Zinc in terms of recovered retort zinc and recovered zinc in zinc oxide.
[d] May include some Cripple Creek and Park County metallics.
[e] Average assay of greater part of original ore for which data were available. (Lead "wet" assay.)
[f] Average assay of original content; no deductions for loss in smelting. All to zinc plants.

The course of treatment of Leadville ores from mine mouth to market was shown graphically in Mineral Resources for 1911, Part I, page 547, figure 1. With the exception of the quantity of ore, the flow sheet for 1911 applies for 1919 in nearly all the details.

During 1919 the A. V. smelter of the American Smelting & Refining Co. was operated steadily but at less than half capacity on Leadville ores and ores from other parts of Colorado as well as from Idaho and elsewhere. The Western Zinc Concentrating Co's zinc-oxide plant was operated steadily on low-grade zinc carbonate ores.

The Downtown Mines continued to ship heavily from the properties unwatered in 1916, but the Western Mining Co.'s properties were idle on company account, and only part of the upper levels were operated by lessees working through adjoining properties. The Greenback mine and the Mikado shaft, unwatered in 1917, were closed May 1.

MINES REVIEW.

California Gulch, Iron Hill, and Breece Hill mines as unwatered by the Yak tunnel.—Much of the ore from the mines operated in 1919 under the management of the Yak Mines continued to come from the Cord winze below the tunnel level; other important mines worked from the tunnel were the Dolly B., Habendum, Rubie, North Tenderfoot, Ollie Reed, White Cap, and Winnie. The bulk of the ore was iron sulphide, which was shipped to the lead smelters. Much iron pyrite, chiefly valuable for its sulphur content but also carrying considerable silver and some lead and zinc, was shipped to plants for the manufacture of sulphuric acid, the roasted residue finally reaching lead plants. Very little lead-zinc sulphide ore was shipped. Some low-grade zinc carbonate ore was also shipped to the local zinc-oxide plant.

Iron Hill and North Iron Hill.—After many years of active operation the Iron Silver Mining Co. ceased company operations at the Moyer mine on October 13, 1917, and at the Tucson July 1, 1918. During 1919 lessees on the Moyer mined 10,000 tons, most of it iron sulphide ore for the manufacture of sulphuric acid. Lessees on the A. Y. & Minnie mine shipped a considerable quantity of low-grade zinc oxidized ore and several cars of lead-silver sulphide ore. Lessees on the Adelaide mine shipped a large quantity of pyrite silver ore to lead smelters. Several cars of lead oxidized ore were shipped from the Humboldt mine.

Graham Park.—The Iron Silver Mining Co.'s report for 1919 (dated Leadville, February 14, 1920), covers operations of leases on old properties and the new properties acquired in 1916. The tables below and the accompanying paragraphs are an abstract from that report, which states that active operations on company account were confined to the first quarter of the year.

Iron Silver Mining Co.'s production, 1919.

Class of ore.	Quantity (short tons).	Sales value.
MARIAN MINE.		
Zinc sulphide	8,050	$52,559
Zinc-lead sulphide	4,151	30,078
	12,201	82,637
ALLEGHANY LEASE.		
Zinc sulphide	348	1,647
Zinc-lead sulphide	138	555
Iron sulphide	38	19
	524	2,221
LEASES.		
Zinc sulphide	2,196	19,592
Zinc-lead sulphide	3,021	22,929
Lead carbonate	1,178	7,216
Zinc carbonate	495	3,608
Iron oxide	2,098	9,348
Iron sulphide	4,853	23,604
	13,841	86,297

Development work, 1919.

Mine.	Drifts.	Raises.	Shafts.	Winzes.	Station.	Total.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Marian	625	160	0	0	0	785
Pyrenees	0	0	360	0	15	375
Moyer	523	142	0	0	0	665
Dome	332	103	65	0	0	500
Iron	215	35	0	85	0	335
	1,695	440	425	85	15	2,660

Operations at the Marian mine for the first three months of 1919 were most satisfactory, but the steadily declining prices for zinc produced actual losses for the operations in February and March. Meanwhile a portion of the main working shaft had again become so badly crushed and distorted that repairs became necessary, and in consequence the greater portion of the underground force was laid off on April 10. While this repair work was under way the labor situation in the Leadville district became greatly disturbed and the dispute over wages resulted in a complete walkout of the miners on April 20.

In order to save the valuable pumping equipment the pumps had to be pulled and put in a place of safety—a task that was practically completed on the morning of April 20. Since that time the mine has been flooded.

During the short operation of the upper portion of the Marian mine by the Iron Silver Mining Co. a pyritic zinc and lead sulphide deposit was developed and mined, and it is estimated that 50,000 tons of similar ore was left in place when the mine was closed. The developments of the year indicated also the probable existence of additional ore deposits in the deeper parts of the company's holdings in the Graham Park area.

The Mikado Lease, an association operating the Venus and other claims through the Mikado shaft of the Iron Silver Mining Co., shipped considerable zinc sulphide ore until the closing of the shaft. A considerable quantity of pyritic ore carrying some silver, gold, lead, and zinc was shipped to sulphuric acid plants in Denver (with small quantities to the Eastern and Southern States), and several thousand tons of silver pyrite ore was shipped to lead plants from the Greenback mine until closed in May.

Ball Mountain.—Lessees shipped several cars of lead-silver ore from the Sunday mine.

Breece Hill.—The principal gold mines of the Leadville district are on Breece Hill and in South Evans Gulch. In 1919 lessees on the property of the Ibex Mining Co. continued to ship large quantities of all the various grades of ore, including some metallic gold. Iron sulphide gold and silver ore was shipped by the Garbutt Leasing Co. from the Dennis, Garbutt, Mary Alsberg, Maud Hicks, Nonie, and St. Paul claims. Other producing mines were the Big Four, Breece Iron, Fanny Rawlings, and President.

South Evans Gulch and Little Ellen Hill.—Lead oxidized, zinc sulphide, and zinc-lead sulphide ores, carrying gold and silver, were shipped from the New Monarch mine by lessees.

Carbonate Hill.—The Wolftone shaft was closed early in 1919. Before pulling the pumps the lower levels were bulkheaded from the Greenback mine. During January and February the Western Mining Co. shipped some zinc-lead sulphide and pyritic silver ores, and during the rest of the year lessees on the upper levels shipped a considerable quantity of iron-manganese-silver flux to lead smelters and zinc carbonate ores to the Ohio Zinc Co.'s zinc oxide plant at Canon City. Lessees on the Catalpa, Crescent, Morning Star, and Evening Star mines shipped some zinc carbonate ore and several thousand tons of iron-manganese-silver fluxing ore to smelters.

Iron-manganese ore was shipped to steel mills from the Carbonate mine.

Fryer Hill and Stray Horse Gulch.—Iron-manganese-silver ores were shipped from the All Right (Fairview), Denver City, Dunkin, Gambetta-Seneca, Little Chief, Little Sliver, Matchless, Robert E. Lee, and Tip Top. Some zinc carbonate ore was shipped from the Denver City-Shamus O'Brien, oxidized lead ore from the Little Chief, and siliceous oxidized silver ore from the Little Sliver.

Printer Boy Hill.—The Lilian mine shipped several pieces of metallic gold, oxidized lead ore, and zinc carbonate ore.

Rock Hill.—Lead oxidized ore and siliceous silver ore were shipped from the La Plata, and iron-silver oxidized ore from the Emmett mine.

Iowa Gulch.—Two cars of silver oxidized ore were shipped from the Long & Derry mine.

Downtown district.—From the properties under the control of the Down Town Mines Co., worked through the Penrose shaft, were shipped large quantities of ore, including lead oxidized, zinc carbonate, iron-manganese fluxing, copper oxidized, zinc-lead sulphide, lead sulphide, and iron-manganese (to steel mills) ores. The C. J. Dold Mining Co. shipped a considerable quantity of iron-manganese ores to steel mills until July 1, when its contract for these ores expired, and some iron-manganese fluxing ores up to the time of closing the mine in October. Similarly the A. V. mine was operated steadily for the first six months of the year only, shipping a considerable quantity of iron-manganese ore to steel mills.

OTHER DISTRICTS.

St. Kevin, Sugar Loaf, and Independence districts.—From the early days of mining in Lake County there has been production from the district lying along the base of the Sawatch Range, including St. Kevin and Sugar Loaf Mountains. Lessees on a small part of the Griffin mine shipped 25 cars of silver ore. Lessees on the Inez (Dinero) mine shipped several hundred tons of comparatively high-grade silver ore.

Twin Lakes and Lackawanna Gulch districts.—A small car of gold ore was shipped from the Fidelity mine. The Mount Champion mine and mill were idle.

Arkansas Valley dredge district.—At the mouth of Rock Creek, 12 miles from Leadville, the Derry ranch 5 cubic foot dredge continued successful operations in 1919.

Granite district.—Several ounces of placer gold was sluiced from gravels of Arkansas River near Granite.

LA PLATA COUNTY.

Mine production in La Plata County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	14	300	$7,378	6,415	668	3,000	$14,171
1919	12	405	5,966	6,075	167	2,283	12,922
Increase or decrease, 1919	−2	+105	−1,412	−340	−501	−717	−1,249

All the ore produced in La Plata County was shipped direct to smelters.

La Plata (California) district.—The mines of the La Plata district are in the La Plata Mountains, in the drainage basin of La Plata River, near the town of La Plata, 10 miles from Hesperus, the shipping point of the Rio Grande Southern Railroad.

Several hundred tons of gold-silver ore was shipped from the Valley View mine, and several cars of silver ore from the Jumbo mine. Small lots of ore were shipped from the Bessie G., Durango Girl, Eagle Pass, Kennebec, Little La Plata, Muldoon, Small Hopes, and Tomahawk mines.

Development work was done in this district by the Boren Gulch Gold Mining Co., Cumberland Mines Co., and Lewis Mountain Mining & Milling Co. (Ten Broeck).

MINERAL COUNTY.

Mine production in Mineral County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine oz.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	11	28,372	$13,943	640,959	3,490	989,620	.....	$726,027
1919	13	16,718	9,083	369,575	355	934,113	96,274	479,609
Increase or decrease, 1919	+2	−11,654	−4,860	−271,384	−3,135	−55,507	+96,274	−246,418

Creede district.—The Creede district embraces the most valuable deposits in Mineral County. In 1919 the output of silver decreased 42 per cent.

The Creede Exploration Co. (subsidiary of the American Smelting & Refining Co.), which had been unwatering and developing in 1917–18 a large area in the heart of the Creede district, shipped a large quantity of silver ores before abandoning the enterprise early in 1919. The Monon Mining Co. continued to ship silver ore in quantity from the Quintette-Monon group. The Solomon 25-ton water-concentration mill was operated on lead-zinc ores from the Solomon and Ethel claims during the life of a lease on the property from January 1 to May 9. The Humphrey water-concentration oil-flotation mill was idle.

Producing mines included the Alpha, Amethyst, Bachelor, Commodore, Corsair, Del Monte, Equity, Last Chance, Melissa, Manitoba, Mollie S., Monon, New York, Riverview (a blanket surface deposit on Bachelor Mountain), and Solomon-Ethel.

MONTROSE COUNTY.

Several ounces of placer gold was sluiced from the Luhr's placer, 23 miles from Naturita, on Dolores River.

A large force of men was employed from March through December at the Cashin mine by the Michigan Colorado Mining Co. Surface operations were the erection of buildings and the construction of roads, and underground operations consisted of exploratory sinking and driving.

OURAY COUNTY.

Mine production in Ouray County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	38	79,653	$107,645	801,359	153,117	2,587,915	39,297	$1,134,142
1919	23	64,465	92,338	627,659	112,188	1,782,868	23,343	912,379
Decrease, 1919	15	15,188	15,307	173,700	40,929	805,047	15,954	221,763

Red Mountain district.—The Red Mountain district from 7 mines produced 1,798 tons of ore, yielding $29,584 in gold, 16,383 ounces of silver, 86,140 pounds of copper, 139,679 pounds of lead, and 23,343 pounds of zinc and having a total value of $73,062, as compared with $65,170 in 1918.

The Barstow mine was operated throughout the year and the mill during the summer, with a lead concentrate product carrying a high average content of gold. A considerable force of men was employed throughout the year by the Red Mountain Mines Co., reopening the Robinson, Yankee Girl, and Genesee-Vanderbilt mines. The work done consisted of unwatering the shaft, reopening old workings, shaft retimbering, drifting, stoping, crosscutting, and raising. The 30-ton water-concentration oil-flotation mill was operated for 91 days on lead-zinc ore, producing a lead concentrate and a lead-zinc concentrate. Several cars of copper sulphide ore, carrying a high content of both copper and silver, were shipped from the Guadalupe mine to copper smelters near Salt Lake City. Small shipments of ore were made from the Beaver-Belfast, Hudson, Indiana, and St. Lawrence.

Sneffels district.—The Sneffels district in 1919 from 6 mines produced 61,049 tons of ore, yielding $58,695 in gold, 548,642 ounces of silver, 22,957 pounds of copper, and 1,522,341 pounds of lead and having a total value of $758,128, as compared with $885,527 in 1918.

The Atlas 100-ton 20-stamp water-concentration oil-flotation mill, despite a shortage of labor, was operated continuously and produced a lead-silver-gold concentrate. The Humboldt mine was operated steadily from the Telluride side of the mountains, through the Smuggler Union Mining Co.'s workings, and all ore was milled at the Smuggler Union mill. (The ore treated and content recovered are credited to Ouray County.) The Mountain Top mine was operated 365 days, and the 50-ton water-concentration oil-flotation mill (built underground) was operated 298 days and produced a lead concentrate with a high content of silver. In addition, several hundred tons of lead ore carrying a high silver content was shipped direct from this mine to smelters.

Uncompahgre district.—The Uncompahgre district produced from 11 mines 1,618 tons of ore, yielding $4,059 in gold, 62,634 ounces of silver, 3,091 pounds of copper, and 120,848 pounds of lead, with a total value of $81,189, as compared with $183,445 in 1918. The principal producing mine was the Wedge, on which a force of men was

employed continuously drawing old stope filling, which was screened and sorted before sending to smelters. The ore is siliceous, carrying chiefly silver. Other producing mines were the Bachelor-Khedive, Bright Diamond, Calliope, Monarch, Newsboy, Raven, Rose, and Senorita.

PARK COUNTY.

Mine production in Park County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.		Silver.[a]	Copper.	Lead.	Total value.
			Placer.	Deep.				
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	
1918	11	2,304	.....	$63,176	18,280	12,704	233,873	$101,199
1919	9	11,210	$4,135	125,422	70,949	20,436	305,908	229,034
Increase or decrease, 1919	−2	+8,906	+4,135	+62,246	+52,669	+7,732	+72,035	+127,835

[a] Includes placer production.

Buckskin district.—Continuation for the first six months of 1919 of the reopening of the Fanney Barrett mine resulted in the shipment of a car of manganese ore and two cars of gold-silver ore. A car of gold ore was shipped from the Paris mine.

Consolidated Montgomery district.—The 150-ton concentration-flotation mill at the Dolly Varden mine was operated on a considerable quantity of siliceous sulphide silver-lead ore, with a product of lead-silver concentrate. At the mine considerable development work consisted chiefly of driving of drifts. The Russia mine was reopened and a car of silver ore shipped. Some placer gold was recovered by sluicing gravels along Platte River.

Fairplay district.—The testing and drilling of placer areas in the Fairplay district was continued in 1919, and the pit for a dredge was excavated.

Freshwater district (Guffey).—A force of 3 men was employed at the Mill Gulch property for 11 months on development work.

Hall Valley district.—At the Whale mine the 60-ton table-concentration oil-flotation mill, built in 1918, was operated from July through October and produced lead-silver concentrate. Development work was done at the Missouri property.

Horseshoe district.—Much development work was done at the Hill Top mine. Two cars of silver ore were shipped from the Minerva mine.

Lake George (Pulver) district.—Some development work was done in the Lake George district.

Mosquito district.—Development work was carried on all the year by the two men at the Champaign mine, and a small lot of silver ore was shipped. Several cars of lead-silver ore were shipped from the Hock Hocking mine. Lessees working continuously at the London mine shipped a large quantity of ore carrying a high content of gold. At this property 600 feet of work was done in driving a new adit 758 feet below the present mine workings.

Tarryall district.—The hydraulic plant on the Fortune placers, operated by lessees for 92 days, handled a considerable yardage of gravel, from which a very good recovery of gold was made.

PITKIN COUNTY.

Mine production in Pitkin County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	15	98,413	$2	558,722	9,684	11,666,592	145,286	$1,402,665
1919	12	121,534	.....	657,058	.....	5,310,170	80,000	1,023,184
Increase or decrease, 1919..	−3	+23,121	−2	+98,336	−9,684	−6,356,422	−65,286	−379,481

Aspen (Roaring Fork) district.—The Smuggler Leasing Co. continued to ship lead-silver oxidized ore and some zinc oxidized ore to smelters and lead-silver sulphide ore to its 360-ton concentration mill from a large area of mineral ground held under lease. Ore was shipped from the Smuggler, Della S., Bushwhacker, Durant, Aspen, Park Regent, and Late Acquisition mines. Lessees on the Aspen Fraction, Millinee, and Spar shipped much silver ore direct to smelters. Lessees on the Pride of Aspen mine shipped ore to the Smuggler mill. The Hunter Creek Leasing Co. continued to move the Cowenhowen dump to the Hunter Creek concentration mill, with product of lead concentrate. From the Newman Tunnel group was shipped a considerable quantity of lead sulphide ore direct to smelters. The Park Tunnel Mining & Milling Co. continued driving on its adit to reopen long idle properties in Tourtelette Park, the objective being estimated at 3,000 feet from the portal. The Hope Mining & Leasing Co. continued to drive its crosscut adit to cut the Little Annie and other mines at depth. The Richmond Hill Mining, Milling & Leasing Co., sublessees on the Hope ground above the 400-foot level of the Little Annie, remodeled the old 10-stamp mill (stamps not used) by installing a ball mill and oil-flotation cells and operated the mill for a period on low-grade silver ore, sending the higher-grade ore direct to the smelter. The Hurricane Co., operating some of its own property and several claims under lease from the Hope Co., continued development throughout the year. The Midnight Co. continued driving its adit from Queens Gulch to connect with the Midnight shaft.

ROUTT COUNTY.

A car of silver-gold concentrates was shipped from the Royal Flush concentration mill, and small lots of silver ore were shipped from the Master Key and from the Minnie D.-Newcastle claims in the Hahns Peak district.

Assessment work only was done in the Slater district in 1919.

SAGUACHE COUNTY.

Baca Grant district (Liberty).—A power plant and machinery was installed at the Golden Treasure property.

Kerber Creek (Bonanza) district.—All the production of Saguache County in 1919 came from the Bonanza district. A large force of men was employed at the Cocomongo mine during the first six months of the year, but only a few men were employed during the last six months. Shipments of several hundred tons of silver ore carrying copper and some lead went direct to smelters. Other producing mines were the Joe Wheeler, Liberty, Now What, and Rico. At the Eagle mine a 50-ton flotation mill was built.

Mirage district.—At the Midnight claim the shaft was sunk 20 feet and 45 feet of trenching was done.

SAN JUAN COUNTY.

Mine production in San Juan County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	37	132,927	$257,011	477,322	1,120,178	9,485,775	3,410,308	$1,994,845
1919	20	64,899	132,560	279,667	661,667	5,443,906	1,833,768	991,249
Decrease, 1919.	17	68,028	124,451	197,655	458,511	4,041,869	1,576,540	1,003,596

Animas district.—The Animas district (including the mines in the vicinity of Silverton and south and east of Animas River from Silverton to Middleton) produced 32,219 tons of ore, yielding $95,547 in gold, 198,676 ounces of silver, 469,597 pounds of copper, and 4,080,813 pounds of lead, with a total value of $621,692, as compared with $1,063,172 in 1918.

There were 22 producing mines, a decrease of 6. The chief producing properties were the Dives, Highland Mary, Iowa-Gold Tiger, and Mayflower. The Dives mine was operated continuously, with shipments of lead sulphide ore, assaying well in both silver and lead. The Highland Mary mine was operated only from June through December, but during that time several hundred tons of lead-silver ore was shipped. The Iowa-Tiger mine was operated steadily, and a large quantity of lead-silver ore was sent over the aerial tram to the Iowa-Tiger table-concentration oil-flotation mill, the product of which was a very good grade of lead-silver-gold concentrate. The flotation part of the mill was used only for the treatment of tailings and was in operation for only a short time. The Mayflower Leasing Co. operated the Mayflower mine steadily, sending the ore to the Iowa-Tiger mill for treatment, the product being lead-silver concentrate.

Several men were employed on development work at the Caledonian group. A small force of men employed steadily at the Emerald mine shipped several cars of copper-silver sulphide ore. The Detroit & Colorado Leasing Co. shipped several cars of copper-silver ore from

the Champion No. 2 mine. Lead-copper-silver ore was shipped to Durango from the Hercules mine. Lessees on the Silver Lake mines shipped a few cars of silver-lead ore to the Durango smelter. At the Little Nation mine a road was built, a compressor installed, several mine buildings and an ore bin and sorting house erected, and much development work done underground, with the shipment of two cars of lead-silver ore. Copper-silver ore was shipped from the Champion No. 1 mine.

Eureka district.—The Eureka district (north of Silverton, including Chattanooga, Animas Forks, Eureka, and Red Mountain) produced 32,680 tons of ore, carrying $37,013 in gold, 80,991 ounces of silver, 192,070 pounds of copper, 1,363,093 pounds of lead, and 1,833,768 pounds of zinc and having a total value of $369,557, as compared with $931,673 in 1918.

The Sunnyside Co., which had been occupied in 1917–18 in the building of a new 500-ton flotation mill, mine buildings, and living quarters at Eureka, was able to carry on regular operations for only four months, for a fire at the property on April 26 made it necessary to rebuild the boarding house, bunk house, compressor plant, commissary, warehouse and office, framing shop, emergency hospital, and snow sheds.

The Gold King Extension Mines Co. employed a large force of men during the year. The underground workings were reopened, and ore was sent to the old 80-stamp amalgamation-concentration plant from January 1 to August 9. The remainder of the year was occupied with the installation of new crusher, stamps, concentration tables, and flotation cells.

From mines near Red Mountain was shipped several hundred tons of copper-silver-gold ore from the Congress, and several cars of ore from the Henrietta and the St. Paul. Silver-lead and zinc-lead sulphide ores were shipped from the Silver Ledge mine. The Ruby mine was reopened for inspection.

Three men working at the Early Bird prospect, on Houghton Mountain, drove an adit 40 feet long and shipped a small lot of gold-silver ore to the Salida smelter.

SAN MIGUEL COUNTY.

Mine production in San Miguel County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.	Copper.	Lead.	Zinc.	Total value.
		Short tons.		*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	27	374,134	$2,127,634	836,570	992,814	6,044,085	797,648	$3,711,145
1919	13	428,565	2,105,490	1,100,942	913,925	7,636,790	515,082	3,950,886
Increase or decrease, 1919	−14	−54,431	−22,144	+264,372	−78,889	+1,592,705	−282,566	+239,741

Upper San Miguel district.—The Upper San Miguel district in 1919 produced 427,841 tons of ore, carrying $2,104,263 in gold, 1,066,192 ounces of silver, 898,936 pounds of copper, 7,243,263 pounds of lead,

and 515,082 pounds of zinc, with a total value of $3,887,094, as compared with $3,622,077 in 1918.

The three large companies, the Liberty Bell, Smuggler Union, and Tomboy, continued to furnish the greater part of the total output. The Smuggler Union mill also treated a large quantity of lead-zinc ore from the Black Bear mine (in San Miguel County) and of silver ore from the Humboldt mine (in Ouray County, to which production is credited).

The Belmont-Wagner Mining Co., which took over the Alta mines in 1917 and did much development work in 1917 and 1918, including remodeling of the mill, operated the 250-ton oil-flotation mill (followed by table concentration) from June throughout the year, with product of lead-silver-gold concentrate. About 21,000 feet of development work has been done on this property.

The Cimarron 40-stamp table-concentration mill was operated for 100 days, with product of gold concentrate.

The Black Bear mine was operated on a productive basis for only 4¼ months, the remainder of the year being devoted to a large amount of development work. The ore, a lead-zinc-copper sulphide, was milled at the Smuggler Union mill, and a copper-lead-zinc concentrate was shipped to the River plant at Florence and a copper-lead concentrate to the Durango smelter.

The Liberty Bell concentration-cyanidation plant was operated 363 days. Since May, 1918, no concentrate has been shipped to smelters.

The Smuggler Union 650-ton amalgamation-table and vanner-concentration oil-flotation mill was operated continuously on ores from the Smuggler Union properties and from the Humboldt (Ouray County) and Black Bear mines. During the year a 200-ton ball mill was installed, increasing the capacity of the concentration mill 200 tons a day. Lessees working on the upper levels of the Smuggler Union mine, drawing old stopes of oxidized gold ore, sent this material to the 30-ton Barbara mill, equipped with a ball mill and a Huntington mill and tables, with product of amalgam bullion and gold-silver concentrate.

The Tomboy 60-stamp amalgamation table-concentration mill and 400-ton cyanidation plant for tailings were operated continuously until August, when in order to arrange for the installation of the new 500-ton flotation plant the old cyanide plant was shut down, and on November 22 the rest of the old milling plant was entirely dismantled. The new plant commenced operations, as to one unit, for five days in December, 1919, and the complete new plant was put in commission in January, 1920.

The annual report of the Tomboy Gold Mines Co. (Ltd.), dated October 8, 1919, for the year ended June 30, 1919,[1] says

that 155,334 tons of ore have been milled, from which bullion and concentrates to the value of $864,699 has been realized, at a cost of $781,397, resulting in a profit of $83,302. Deducting from this profit the loss incurred on the boarding house, etc., $8,745, the total surplus on the year's working will be found to correspond with the figures given in the manager's report, namely, $74,557. The average working costs for the year, including all expenses in America and London, were $5.10.

The following estimate of the ore reserves, exposed by the present developments are: In the Argentine group of mines, 200,000 tons, of which 100,000 tons are broken in the stopes; and in the Montana property, 300,000 tons, of which 150,000 tons are broken in the stopes.

[1] See also Eng. and Min. Jour., Jan. 10, 1920, p. 78.

From the Argentine group nearly 28,000 tons were milled, being about 18 per cent of the total for the year.

Of the total amount of ore milled during the year about 127,300 tons, or roundly 82 per cent, were supplied by the Montana group.

After exhaustive experiments, carried out on a practical scale on ore taken from all parts of the mine, the board authorized the erection of an oil-flotation plant, and the work of construction has been prosecuted with vigor during the past year. The latest advices from the general manager are to the effect that the plant should be in operation during the month of December.

The net results of the year's operations have been the most unfavorable of any year for over a decade and a half. The unusual economic and industrial conditions prevailing during the last months of the war and the first months of the reconstruction period have been the indirect underlying factors in the comparatively unprofitable results of the year's operations; while unfavorable mine conditions, induced by insufficient and inefficient labor, prevented realizing on the better-grade reserves of the mine for several months of the year and directly contributed to the unsatisfactory returns.

The cyanide plant treated 122,624 tons of tailings, recovering therefrom bullion valued at $158,222.61, and slag to the value of $2,967.08, or a total value of $161,189.69, at a cost of $1.131 per ton, and yielding a net profit of $0.183 per ton of tailings treated.

Revenue and expenditure, Tomboy mine, June 30, 1918, to June 30, 1919.

155,334 dry tons ore milled, yielding bullion worth			$265,796.55
Concentrates worth			437,712.77
Cyanide bullion worth			158,222.61
Cyanide slag worth			2,967.08
			864,699.01
Less loss on boarding house, rents, etc			8,745.52
			855,953.49
Mining and developing expenses	$2.21 per ton.	$343,065.91	
Milling expenses	.67	104,403.95	
Concentrating expenses (including transportation to railway)	.53	81,970.12	
Water-supply expenses	.09	14,641.80	
Assay-office expenses	.05	7,237.69	
Cyaniding expenses	.88	137,013.81	
General expenses	.33	51,855.17	
Taxes and insurance	.27	41,208.01	
Total expense	5.03		781,396.46
Profit			74,557.03

The Gold Run Placer Co. operated from June through December a small mill equipped with thickeners and Wilfley tables, on tailing carried by San Miguel River, with product of silver-gold concentrate.

Iron Springs (Ames and Ophir) district.—The Iron Springs district produced 724 tons of ore, carrying $1,227 in gold, 34,750 ounces of silver, 14,989 pounds of copper, and 393,527 pounds of lead, with a total value of $63,792, as compared with $88,733 in 1918. Several hundred tons of lead-silver oxidized ore was shipped from the Carbonero, the most productive mine in the district. Small shipments of lead sulphide ore were made from the Carribeau and San Bernardo. The Valley View Leasing & Mining Co. retimbered the 1,500-foot adit on the San Bernardo and in October, began the erection of a 100-ton water-concentration oil-flotation mill. Small lots of copper sulphide ore were shipped from the Crown Point and Santa Cruz mines. The Matterhorn Mining & Milling Co., working from the Butterfly adit from April through December, did repair work and

prospecting for ore and made repairs on the Butterfly-Terrible amalgamation-concentration mill.

The Summit Metal Mines Corporation began in October the remodeling of the Suffolk 100-ton cyanidation-concentration mill and the reopening of the 1,000-foot adit.

SUMMIT COUNTY.

Mine production in Summit County, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.		Silver.[a]	Copper.	Lead.	Zinc.	Total value.
			Placer.	Deep.					
		Short tons.			*Fine ounces.*	*Pounds.*	*Pounds.*	*Pounds.*	
1918	36	58,185	$431,023	$36,116	117,326	13,206	777,338	15,696,264	$2,071,278
1919	33	17,567	464,540	11,351	87,676	6,086	446,491	4,047,096	894,322
Increase or decrease, 1919	−3	−40,618	+33,517	−24,765	−29,650	−7,120	−330,847	−11,649,168	−1,176,956

[a] Includes placer production.

There was a heavy decrease in deep-mine production of all metals, and particularly of zinc, in Summit County in 1919. Dredges and other placer operations, however, yielded $464,540 in gold and 5,942 ounces of silver, valued at $6,655, a total of $471,195, as against $431,023 in gold and 5,353 ounces of silver in 1918.

The principal placer-producing district in Colorado is near Breckenridge, Summit County. This county is also one of the principal zinc-producing counties.

Breckenridge district.—The Breckenridge district includes the Bevan, Minnesota, and Union districts and includes all the mines (near Breckenridge) on French Gulch and on Blue and Swan rivers and all producing placers in the county. The value of the total output of gold, silver, copper, lead, and zinc from both deep and placer mines was $809,912, or 91 per cent of the county yield, but a decrease for 1919 of $1,116,724.

The Wellington mine continued to be the principal producing property in the district. Early in 1919 this company found itself without a market for its zinc concentrate, but continued milling operations for a few months, storing its concentrate. Then for a period only development work was done at the mine. In September shipment of the stored concentrate began, and in December the force of men at the mine was increased, but the number was not equal to that employed in January to March. The Wellington mills include a 115-ton wet-concentration mill, making a lead concentrate, zinc-iron middling, and a silica tailing, and a 90-ton magnetic separator for treatment of the middling, making a zinc concentrate and an iron tailing.

Several cars of silver oxidized ore were shipped to smelters from the Brooks-Snyder mine. Lead oxidized ore was shipped from the Carbonate, Iron Mask, June Bug, Price, and Sunnyside. A car of silver oxidized ore was shipped from the Quandary Queen mine. From the Standard dump several hundred tons of silver oxidized

ore was shipped. A car of silver ore was shipped by lessees from the Minnie B mine, on Mount Guyot.

The Royal Tiger Mining Co. employed a large force of men throughout the year on extensive development work, including the building of a 50-ton table and jig-concentration oil-flotation mill.

For the first six months of the year development work was done at the Laurium (Blue Flag) mine. During the last five months two men were employed in reopening the Warriors Mark mine, idle for years.

Five dredges were in operation, all operated by electricity. The Powder River Gold Dredging Co.'s dredge (new in 1918) was operated on the B. & L. and other placer claims from January 1 to October 31, when it was turned over to the Blue River Dredging Co., which operated it the remainder of the year. This dredge has 70 buckets of 8 cubic feet capacity each. The French Gulch Dredging Co.'s dredge of 80 buckets of 5 cubic feet capacity was operated for 249 days. The annual report of the Tonopah Placers Co. (subsidiary of the Tonopah Mining Co. of Nevada) says of its three dredges, two of which have each 84 buckets of 9 cubic feet capacity and one 84 buckets of 5½ cubic feet capacity.

Dredge No. 1 has been operating during the year on the Magnum Bonum placer. The tracks of the Colorado & Southern Railroad extended over this ground and divided the claim. While dredging in a southerly direction on this claim, it was found necessary that a strip of land, containing a dredgeable area of 28.2 acres on bed rock would have to be passed by in order to give sufficient lateral support to the roadbed to prevent it caving. To remedy this, negotiations were opened with the railroad company and the United States Railroad Administration, which resulted in removing the roadbed to a new location at the extreme western limits of the placer boundaries. This was accomplished at a cost of $12,476.04, which was paid by the Placers Co. This transfer of the railroad tracks to the new right of way renders available for dredging an area of 32 acres.

The No. 2 dredge was operating during all the year upon the ground of the Farncomb Hill Gold Dredging Co. This ground proved to be of such low value that the dredging in it was unprofitable. It was finally decided to suspend the operation of the dredge until drilling could be done to determine the proper course to pursue in the future. The dredge was closed down about the middle of December.

The No. 3 dredge was in continuous operation since April upon ground that had been left by other dredging operations some years ago. On resuming the operations of this dredge in the coming spring it will be necessary to dig a narrow strip of ground between two lots of tailings left in the previous dredging.

Comparative balance sheet of Tonopah Placers Co. for year ending December 31, 1919.

	Dec. 31, 1918.	Dec. 31, 1919.	Increase.	Decrease.
Assets:				
Property	$883,280.73	$771,317.50		$111,963.23
Dredges	191,881.48	308,104.19	$116,222.71	
Material and supplies	99,689.17	84,594.31		15,094.86
Victory loan (liberty) bonds		5,000.00	5,000.00	
Accounts receivable	18,640.90	13,885.96		4,754.94
Prepaid insurance and taxes	1,981.90	2,627.14	645.24	
Cash	32,635.97	48,292.07	15,656.10	
	1,228,110.15	1,233,821.17	5,711.02	
Liabilities:				
Capital stock	1,000,000.00	1,000,000.00		
Notes outstanding	56,000.00	56,000.00		
Accounts payable	91,701.46	78,010.71		13,690.75
Taxes payable	373.92			373.92
Reserve for insurance	250.62	514.47	263.85	
Surplus	79,784.15	99,295.99	19,511.84	
	1,228,110.15	1,233,821.17	5,711.02	

Production and income statement of Tonopah Placers Co., for the year 1919.

Surplus, Dec. 31, 1918			$79,784.15
Add: Amount expended for repairs to dredges Nos. 1, 2, and 3, in the years 1915, 1916, and 1917, disallowed by Internal Revenue Department and reinstated for future depreciation		$193,248.73	
Less: Depreciation of 10 per cent in 1918		19,324.87	
			173,923.86
			253,708.01
Net earnings and income for year 1919:			
Gross value of bullion shipped to Mint		309,509.22	
Cost of operations		293,225.27	
Profit in operations		16,283.95	
Other income:			
Earnings from electric lighting plant	$1,605.73		
Storehouse supplies sold	3,175.36		
Interest on bank balance	352.69		
Interest on Liberty Bonds	75.57		
Miscellaneous	1,579.06		
		6,788.41	
Net income for year 1919			23,072.36
Charges against profit and loss account:			
Depletion of 10 per cent on cost of property and 10 per cent on plant and equipment for year 1919			177,484.38
Surplus, Dec. 31, 1919			99,295.99
Cubic yards dredged			3,122,571
Gold produced		ounces	14,776.48
Silver produced		do	3,852.48
Value per yard			$0.098

Sluicing on the Bemrose, Fairview, Surprise, and Washington placers recovered a total of $4,016 in gold and 51 ounces of silver.

Consolidated Tenmile (Frisco, Kokomo, and Robinson) district.—The Consolidated Tenmile district in 1919 produced from 12 mines 4,948 tons of ore, carrying $6,437 in gold, 43,825 ounces of silver, 1,194 pounds of copper, and 178,453 pounds of lead, with a total value of $65,201, as compared with $125,688 in 1918.

The Elk Mountain Mines Co., operating the Wilfley mines at Kokomo, ran its 100-ton concentration mill for some time and produced a lead-silver concentrate. Lead-silver ore was shipped to smelters from the Felecia Grace mine and lead-silver-gold ore from the Boston mine. From October through December pyritic silver ore was shipped from the Michigan mine to the General Chemical Co.'s sulphuric acid plant at Denver. Silver oxidized ore in considerable quantity was shipped from the Silver Queen mine.

From Frisco a small lot of lead-silver ore was shipped from the King Solomon property and several cars of lead-silver ore from the Four-Most property. The Excelsior amalgamation-concentration mill was idle.

Montezuma district.—The Montezuma district in 1919 produced from 9 mines 272 tons of ore, carrying $234 in gold, 11,792 ounces of

silver, 3,903 pounds of copper, and 95,132 pounds of lead, with a total value of $19,209, as compared with $18,954 in 1918.

From the Pennsylvania mine the Liberty Mining & Reduction Co., operating four months, shipped several cars of silver-lead ore. Lessees on the St. John mine shipped small lots of silver-lead ore. Other properties from which small shipments were made were the Echo, Hancock, More Work, Morgan, Quail, Revenue, and Tempest.

TELLER COUNTY.

CRIPPLE CREEK DISTRICT.

Mine production in Cripple Creek district, Colo., in 1918 and 1919.

Year.	Number of producing mines.	Ore.	Gold.	Silver.		Total value.
				Quantity.	Value.	
		Short tons.		*Fine ounces.*		
1918	57	936,326	$8,119,747	50,665	$50,665	$8,170,412
1919	41	775,986	5,827,816	35,442	39,695	5,867,511
Decrease, 1919	16	160,340	2,291,931	15,223	10,970	2,302,901

In the Cripple Creek district mills and smelters recovered from crude ore and dump ore, from slags, slimes, and from stolen bullion and ore, 281,920.60 fine ounces of gold, valued at $5,827,816.

The Golden Cycle mill at Colorado Springs, a roast-cyanide plant (with subsidiary amalgamation) of 1,200 tons daily capacity, was operated on about three-fourths capacity except for three weeks during the fuel shortage, when the mill gave its coal to the city of Colorado Springs. The Portland roast-cyanide concentration mill was idle in 1919.

In the Cripple Creek district the Portland Co.'s Independence 1,400-ton cyanidation-concentration mill was operated steadily on low-grade company ore and custom ore.

MINES REVIEW.

In Poverty Gulch the producing mines were the Abe Lincoln and the Gold King.

On Tenderfoot Hill ore was shipped from the Queen Bess mine from January to June.

On Globe Hill lessees on the Stratton estate mines shipped from the Deerhorn and from the Keener dump.

On the north slope of Ironclad Hill the producing mines were the Damon, Forest Queen, Jerry Johnson, and W. P. H. The Lincoln Mines & Reduction Co. continued mill construction and experimentation.

On Gold Hill the El Paso Extension Gold Mines Corporation shipped a considerable quantity of ore from the Index mine. A small shipment was made from the Anchoria Leland mine. Shipments were made from the Midget mine from March to August and from the Lexington from August to December.

On Raven and Guyot hills the producing mines were the Cresson, Doctor-Jack Pot, Elkton, Jo Dandy, and Mary McKinney. Ship-

ments were also continued from the Economic dump. The Cresson continued to be one of the principal producing mines in the district.

On Beacon Hill the producing mines were the El Paso and Prince Albert.

On Bull Hill the producing mines were the Blue Bird (Buckeye), Dante, Dexter, Gold Sovereign, Last Dollar, Modoc, Stratton Estate mines (American Eagles, Favorite, Orpha May, Longfellow, Logan, Six Points, and others), and the United Gold Mines Co. group.

Between Altman and Goldfield the producing mines were the Acacia (Burns), Findley, Golden Cycle, Isabella, Victor, and Vindicator. The Vindicator Consolidated Gold Mining Co. in its annual report for 1919 (dated February 10, 1920) says:

As the acute shortage of labor early in the year handicapped the management in its proposed campaign of development, it was decided to make a preliminary investigation of certain areas of the property, which necessitated long drives with diamond drills. As a result of this decision three holes were drilled, totaling about 1,200 feet. The object of this work was to prove the presence or absence of fractured zones favorable to ore deposits. Our ore-bearing structure is such that the diamond-drill core or borings, or both, can not be taken as proof of the presence or absence of commercial ore, but they can be used satisfactorily and economically in proving the advisability of making long crosscut drives, contemplated on geological deductions.

From the data obtained from these drill holes it was deemed advisable to investigate further on the 1900, or bottom level of the Vindicator shaft, an area of comparatively unprospected ground lying to the southeast of that shaft. In this area, at a distance of about 450 feet from the La Bella vein system, commercial ore was intersected by a crosscut, and has been drifted on for a distance of about 350 feet. After sufficient work had been accomplished on this level to determine the existence of an ore shoot, work was started on the levels both above and below, with a view of more definitely proving the existence of a new ore body. On the level below, the eighteenth level of the Golden Cycle shaft, a crosscut to the east from the northerly portion of these workings, has just within a few days intersected a vein carrying values of commercial grade. From its location, course, and dip, we believe it to be the same one as opened above on the nineteenth level of the Vindicator. The work on Vindicator eighteenth level, in this section, should be completed during the coming quarter.

Other than this, the development for the past year, although it has opened up some small shoots of ore, has not augmented the life of the property to any extent.

The ore opened up during the year has not kept pace with the extraction, which has resulted in a decrease of ore reserves of 57,790 tons. The ore reserves in the mine as of January 1, 1920, total 46,440 tons.

Owing to the gradual falling off of the tonnage which could be hoisted, due to the decrease in the number of working stopes, it was necessary, in the third quarter of the year, to discontinue operations at the flotation plant.

This plant could be operated at a profit so long as it was possible to furnish 75 per cent of its capacity from reject derived from ore-dressing operations, and the rest from low-grade stope filling. When the supply to the mill from reject derived from ore dressing dropped below this percentage, operations of the flotation plant were not profitable. It is possible that operations could have been continued at this plant at a profit if we had not been faced with a continual increase in the cost of necessary supplies.

During the year 1919, there were hoisted 143,400 tons of crude ore on company account through both shafts, from which were produced 19,922 tons of shipping product, with a gross value of $718,136; the marketing charges on which were $129,251; and the net returns $588,885.

There were hoisted on lessees' account 55,648 crude tons; and shipments from this source totaled 20,772 tons, with a gross value of $291,065, marketing charges on which were $104,742, leaving a net value of $186,323. The company's royalties on lessees' shipments amounted to $92,525.

On Battle Mountain the producing mines were the Ajax, Granite, Portland-Independence group, Rose Nicol, and Strong. The annual report of the Portland Gold Mining Co. for 1919 (dated February 16, 1920), says:

The great main vein system of the Portland and Stratton's Independence mines, both owned by The Portland Gold Mining Co., from which the major part of its great production has been made, runs in a northwesterly and southeasterly direction practically through the center of your properties, for about three thousand feet, the Independence shaft being not far from the south end of the ore zone, the Portland No. 1 shaft in the center, and the Portland No. 2 shaft in the northern part of the productive zone. The northerly twelve hundred feet of this vein still continues very productive, and has been opened up to a depth of 2,300 feet from the surface.

The physical condition of the mineralized area is satisfactory, the formation being in regular position, with no unusual disturbances. The vein is strong and well defined, the question of volume of mineralization as to depth at which commercial ore will continue to be found, being the unknown quantity. At present, there are no signs of any diminution of values on our 19th, 20th, or 21st levels.

The twenty-first level is the drainage tunnel level, which is 2,131 feet below the surface. The new level now being opened up, 150 feet below the twenty-first, is only 17 feet short of 2,300 feet below the surface, and is designated as the twenty-third level. The new 2,300-foot station on this level was completed the last of December, two sets of pumps of a capacity of 1,000 gallons each having been installed and the crosscut driven to the vein. At this writing, February 10, the water flow is about 300 gallons to the minute, and is being easily handled. The ore bodies and values on this level so far as developed, are fully equal to those of the level above, which has proved to be one of the best levels that has been opened up on your property in recent years.

The equipment for handling the low-grade ore from the filled stopes of the mine to the mill is working satisfactorily. The new transportation tunnel, which was started early in the year at the 700-foot level of the Independence shaft, has been driven under the first large filled stope, where a fair grade of ore is obtained through two chutes, but the tonnage secured is not yet sufficient to permit the mill being run to full capacity. However, when the tunnel has been driven 350 or 400 feet further ahead, and two additional chutes have been installed, we will be able to hoist a large tonnage per day, which we confidently believe will give us, after screening out the waste, enough ore to run the mill to full capacity.

The new equipment installed at the Independence shaft for screening the waste from the low-grade ore being brought from the filled stopes to the mill has given good satisfaction. However, it may be necessary to add additional equipment in the not distant future in order to eliminate still more of the waste and lower-grade ore, unless costs should soon take a downward trend. Before the war, ore of a value of $2 a ton was treated at a greater profit than $3 ore yields at the present time, notwithstanding the many economies instituted during the war period.

Owing to the drawbacks mentioned, the tonnage treated and the profits made by our Independence mill during the past year, were in a measure disappointing. However, the net profits from your mine were very satisfactory, considering the many obstacles that had to be overcome.

Operations of the Portland Gold Mining Co. during 1919.

Gross value of ore mined and shipped		$1,272,720
Values recovered by Independence mill		513,877
		1,786,597
Net cost of mining and milling		1,562,600
		223,997
Revenue from all other sources		6,293
Net profit from operation of mines and mill		230,290

The Rose Nicol Gold Mining Co. in its report dated September 23, 1919, says:

Since April 1, 1919, there has been shipped 2,878 tons, with a gross value of $37,663, which, after deducting freight and treatment charges, war tax, tramming, and sampling, returned to the lessees $16,939, and to the Rose Nicol Gold Mining Co. as royalty $3,171. There is in transit to the Golden Cycle mill about 400 tons of about three-quarter-ounce grade. This you will note shows the beginning of shipments which are just now well under way.

Since the present lessee, the Reva Mining Co., started operations on your property a very large amount of development work has been done.

The lessee has spent a large amount of money on surface improvements, consisting of engine and compressor house, blacksmith shop, office, ore house, water tanks, and an aerial tramway from ore house to railroad, besides installing a hoist, compressor, and other surface improvements.

The underground work done by this lessee consists of retimbering and straightening a part of the old shaft and sinking it to an additional depth of about 425 feet; also running drifts and crosscuts to the amount of about 70 feet on the fourth level, 60 feet on the sixth level, 1,100 feet on the seventh level, 1,950 feet on the eighth level, and 250 feet on the ninth level. During recent months considerable stoping has been done. Besides the above work the Roosevelt drainage tunnel has been extended across the Rose Nicol property, the distance being about 450 feet at a depth of 2,000 feet.

Up until a few months ago several small stopes were taken out, but the ore was low grade. Since that time a stope of fair grade ore about 60 feet and one of about 225 feet long have been opened up. The first is on the ninth level and the last on the eighth level. It is expected that this latter ore body will soon be cut on the ninth level. At the present writing the ore in the eighth level stope appears to be improving, and it is from this ore body that the production in the near future will come. Quite a heavy tonnage has been shipped recently from these ore bodies and from the present outlook it will continue for some time.

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